The Journal of Heredity

(Formerly the American Breeders' Magazine)

Vol. VII, No. 1 January, 1916

CONTENTS

Somatic Segregation, by E. J. Kraus 3
Alaskan Berry Hybrids 8
Report of Committee on Nomenclature 8
Heredity and Sex 9
Two Pheasant Crosses, by John C. Phillips 12
Mendelism Up to Date, a Review 17
High Fecundity in Hens Not a Unit Character 23
Saving the Kokio Tree, by Robert A. Young and the Editor 24
New Publication on Eugenics 28
Sex in Livestock Breeding, by E. N. Wentworth 29
Race Hygiene in Germany, by G. von Hoffmann 32
An Important Character in Grains 32
Cross and Self-fertilization 33
Igorrot X American Metis, by David B. Mackie 34
Osteopsathyrosis, a Review 36
Studying Fruits in Illinois 38
Ancestry of the Goose 39
A Lost Opportunity in Bee Breeding, by E. R. Root 46
Food Plants of American Indians 47
Eugenics on the Farm 47
Tobacco Hybridization 47
A New Type of Cattle for Alaska 48

The Journal of Heredity is published monthly by the American Genetic Association (formerly called the American Breeders' Association) for the benefit of its members. Canadian members who desire to receive it should send 25 cents a year, in addition to their regular membership dues of $2, because of additional postage on the magazine; foreign members pay 50 cents extra for the same reason. Subscription price to non-members, $2.00 a year, foreign postage extra; price of single copies, 25 cents.

Entered as second-class matter February 24, 1915, at the postoffice at Washington, D. C., under the act of August 24, 1912.

Contents copyrighted 1915 by the American Genetic Association. Reproduction of articles or parts of articles permitted provided proper credit is given to author and to the Journal of Heredity (Organ of the American Genetic Association), Washington, D. C.

Date of issue of this number, December 29, 1915.

WIDE RANGE OF VARIATION IN DAHLIAS FROM A SINGLE PLANT

Three flowers of "Spanish Century," the color of which is regularly yellow splashed with red. The three blossoms here shown are from the same stalk. Variations like this may be due to local conditions or to some change in the germ-plasm; the only sure test of their nature is that of breeding; if they did not originate in the germ-plasm, they will not reproduce themselves. (Frontispiece.)

SOMATIC SEGREGATION

Variations in Plants May Be Divided in Two Classes, One of Which Breeds True While the Other Does Not—Modern Work Shows Importance of Former Class in Practical Breeding—Further Study May Aid in Understanding Causes of Variation in General.[1]

E. J. KRAUS
State Agricultural Experiment Station, Corvallis, Oregon

HORTICULTURAL literature generally, and particularly that which deals with ornamentals, abounds in references to bud variations, bud sports or node sports according to the notion of any particular writer. Anyone dealing with plants in quantity is impressed by the differences exhibited by individuals, differences which often it would be desirable to perpetuate, if possible. It has been argued that, if vegetative propagation means simply the dividing up of an individual into many independent parts, all of which are still the same individual, then the extent to which a plant which possessed particular merit could be multiplied and disseminated, would be limited only by the relative ease of propagation. As a result, considerable work has been attempted along the lines of selection of better strains of many kinds and varieties of plants. Practically the whole idea of pedigreed nursery stock, the selection of runners in strawberries, and the reworking to another strain of unprofitable trees or orchards for greater yields or better fruit, is based on the question of bud variation and bud selection. While the evidence from most of the experiments so far conducted along these latter lines is negative, it is by no means safe to conclude that there is nothing in the idea of improvement by such methods. The greatest difficulty which has arisen and led to confusion has been the failure to recognize the difference between those unstable variations due to purely local conditions and those which, while they may be due to local conditions to some extent at least, are a real part of the plant organization and persist even under widely changed environment.

Bud or somatic variations are subject to a broad classification, much as are seminal or seed variations. Three classes are recognizable: modifications (fluctuations), segregations, and mutations. The first class is observed by far the most commonly, and has furnished the material for the larger part of the experiments which have been conducted with an attempt to determine whether superior strains could be built up and maintained entirely by the selection of vegetative parts. The second class occurs in individuals of hybrid, or supposed hybrid origin (the term being used in its broad sense), or in those individuals in which some apparently new character has arisen, but remains associated with the original form and at times exhibits itself wholly independently to a greater or less extent. To illustrate: an example of this latter sort is the manifestation of pure white in the green and white variegation of many plants, or the production of self-colored flowers by certain individuals which normally bear striped flowers. To the third class belong sudden wide changes or departures from the normal character of a plant, such as double flowers, purple foliage, certain instances of the white areas in foliage, fastigiate forms and the like, which apparently are new to that individual. It is difficult, clearly to differentiate the second and third classes, and if one believes that mutations are merely a result of hybrid

[1] Read before the twelfth annual meeting of the American Genetic Association, at Berkeley, Cal., August 5, 1915.

ancestry, class three should not be recognized. At times, even with breeding records, it would be difficult to determine whether a variation should be classed as a segregation or a true mutation; whether, in other words, the new or apparently new character became expressed through the removal of influences which suppressed or masked it, or actually arose anew.

INFLUENCE OF LOCAL CONDITIONS

As stated previously, fluctuating variation is by far the most common of all forms of variability. Such variation is greatly influenced by, and largely may be due to, environment in its broader sense. The production of inferior or superior fruit, whether it be size, color, or even quantity, may be the result of purely local conditions. A few instances of this type of variation and experiences with it are of interest.

Hedrick, in his discussion of pedigreed nursery stock, has pointed out the fact that fluctuations are not stable and, when environmental conditions are changed, characteristics change with them; and, in citing an example, states that "sixty Rome trees all propagated from buds from one branch show quite as much variation as could be found in an orchard of Romes propagated indiscriminately and growing under similar conditions" With nothing more than change of the name of the plant concerned, his statement fully summarizes a number of similar experiments.

An interesting example of range of fluctuation in size of fruit is furnished by a well-regulated Spitzenberg orchard which came under my observation. Generally the trees throughout the orchard produced average-sized fruits. Certain trees, however, consistently produced small, ill-shaped, inferior apples. Various treatments were recommended and tried but to no avail. Finally it was concluded that the trees were of an inferior strain and regrafting to a superior sort was recommended as the only remedy. Accordingly certain of the small fruited trees were severely cut back in the spring and top-worked, slightly less than one-half the number of branches being left so as not to destroy completely the balance of the tree. In the fall these remaining branches matured the finest fruits in the entire orchard; the companion trees which had not been so severely handled produced small fruit as usual. Apparently there was nothing in the idea of an inferior strain so far as these trees were concerned.

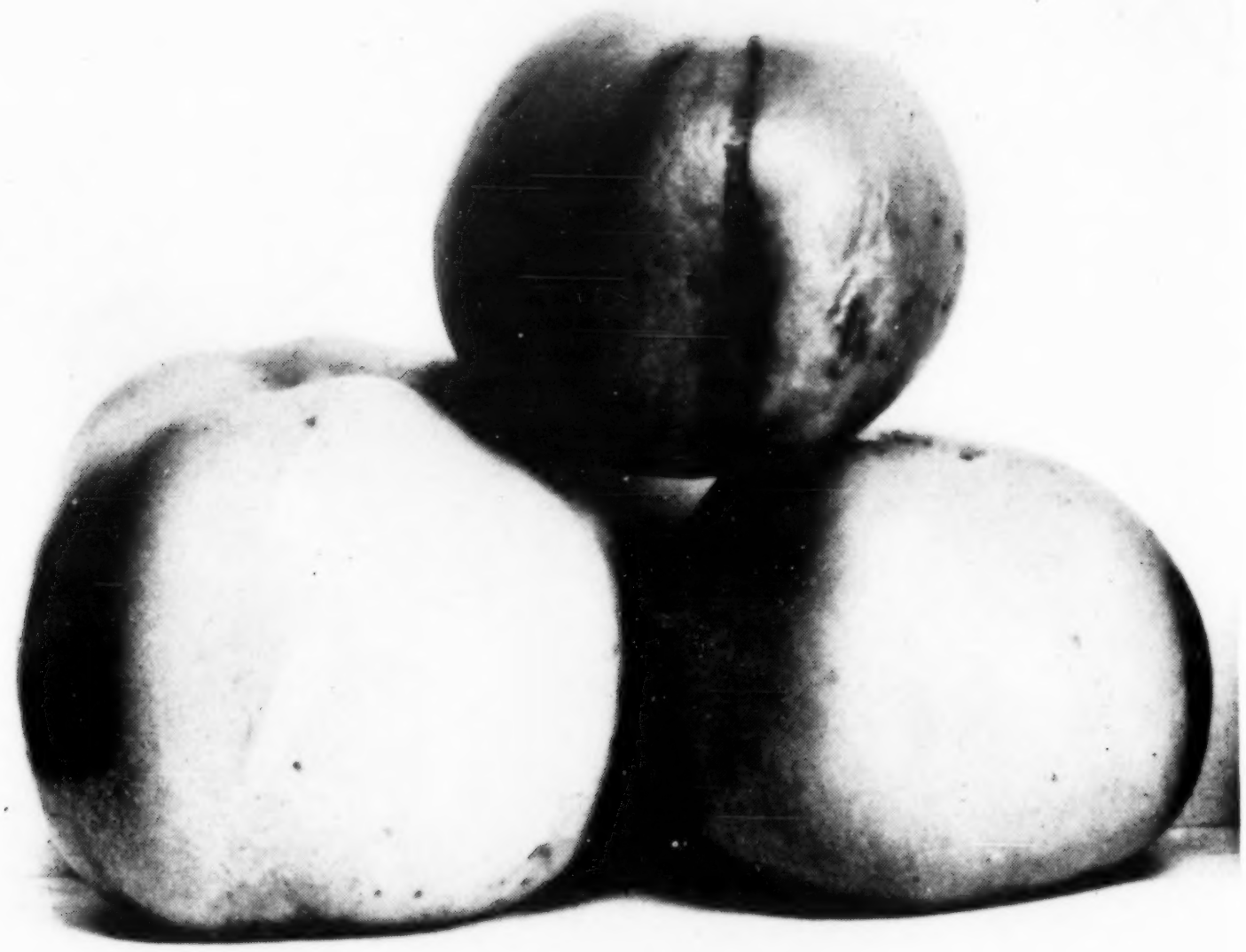
Selection for improvement in apples has been made on the basis of the color of the fruits—one of the most elusive of characters. In this regard, the following statement, which I made some time ago, since has been abundantly confirmed:

> The red in Shiawassee, McIntosh and Jonathan is composed of at least two reds, the one light and carrying with it the factor for striping, the other dark and associated with the factor for solid color. Now if these apples are grown under poor light conditions, they are almost without exception light red and striped, while in full sunlight the deep red factor further manifests itself and the fruit becomes self-colored dark red, though on close inspection the stripes are evident beneath the solid color. This is not a case of segregation; both characters are present, the one being simply overlaid by the other.

If then cions are taken from branches bearing superiorly colored fruit, due to purely local conditions, such as light, air, or moisture, the trees resulting from them when subjected to another environment might or might not prove superior, depending upon whether the new conditions were favorable to the development of the one set of colors or another. As will be brought out subsequently, however, certain color changes, the result of segregation are transmissible.

An experiment by Howard and Whitten, to determine whether the tendency toward greater yield is transmissible, is reported as follows:

> Three crops of apples have thus far been harvested from trees, part of which were grown from cions selected from high-producing parents and part from trees of low-producing parents. There was practically as much variation in yield, size, and color of fruit between trees from the same parent as there was between trees of different parentage. Bud selection from high-producing and from low-producing



A CAUSE OF FREQUENT MISTAKES

Yellow Newtown apples produced by cross-pollinating with Roxbury Russet. The upper fruit has two distinct russet bands, whose appearance is merely a coincidence, and due to the segregation of color originally possessed, not to any direct influence of the Roxbury Russet pollen. Russet is a rather uncommon segregation character in the Yellow Newtown, and it would be easy to suppose that this is a case of immediate influence of pollen were the true explanation not known. Many such erroneous conclusions have been drawn in similar cases. (Fig. 1.)

strawberries carried on through twelve previous years showed absolutely no gain in productiveness by selecting runners from high-producing parents.

More evidence and experiments of the same general nature might be adduced. The one main conclusion to be drawn from them is, that when an attempt is made to propagate a modification it is not transmitted as such alone, but its offspring are capable of developing the entire group or range of variations of which it formed a part.

Evidence and examples of segregations are abundant, and many are being recorded. From this class of variations real advance or regression may be expected. Bateson calls attention to this form of variation and offers, quite correctly, an explanation on the basis of a somatic segregation of parental characters. He cites, as one example, two Sweet-Pea vines, each of which, normally having borne heterozygous purple flowers, produced a lateral shoot which bore red flowers, showing that "the factor B has been omitted in one of the cell divisions by which they were produced." An interesting similar instance of my own observation is worth recounting. A friend who is interested in Sweet-Pea culture crossed two varieties, a pink and a white. From the second generation he secured one form which he has termed an impure dominant. It is white with pink edging, and has given rise through seed to many forms, light pinks, dark pinks, whites, a glowing salmon and a soft salmon rose, this latter being the only form which has not proven variable on further testing. Three years ago this same impure dominant produced a node-sport, a

beautiful glowing rose. Seeds from this sport produced the same rose-colored form, which has remained absolutely fixed. It is of interest to add that through seeds the impure dominant has produced similar pink forms which have not bred true.

Some three years ago Groth called attention to a seeming occurrence of 'xenia' in the peach tomato. This variety normally bears fruits which have much the appearance of very red peaches. The plants in question bore an occasional smooth fruit. Through correspondence, I later learned that experiments demonstrated certain fruits were smooth even when enclosed and protected absolutely from pollination by a smooth sort. Here again, evidently, was a case of somatic segregation, worthy of further testing. A few seeds, said to be from a fruit showing an approach to smoothness, were kindly sent me. Seven plants have resulted from the sowing of a part of the packet; six of them have a few smooth fruits, many intermediate and a few which are rough. One plant has so far produced fifty-four fruits, all very rough and pubescent. It will be of interest to determine the behavior of seedlings from the several types of fruits.

Tufts has pointed out a somatic segregation of characters in the Le Conte pear and Transcendent Crab apple, a segregation which closely approaches a simple Mendelian ratio. He ascribes this segregation to a hybrid origin of the two varieties.

VARIATIONS IN BARTLETT PEAR

A color variation of the Bartlett pear was found several years ago. It occurred as a branch on a normal tree, and differed from the normal in that the bark was a golden yellow, striped green and brown, and the fruit had prominent yellow stripes from calyx to stem. Buds from this branch have reproduced trees of two entirely distinct types. The dark form is scarcely to be told from the ordinary Bartlett; the light form is a much less vigorous grower, has golden-yellow bark tinged with pink and grows very shrubby, producing large numbers of short laterals. Normal Bartletts of the same age as the variegated trees bloomed to a limited extent last year, and profusely this year. The light form produced but two fruit clusters on a total of seven trees; the dark form had no fruit buds at all. The light form so far has not produced bloom from axillary buds on one-year wood, though normal trees have done so in abundance. This case is mentioned since it may possibly represent a case of perpetuation of a change in form, productiveness and color.

The color of fruits of apple furnishes an interesting example of segregation. By comparing with breeding records the various colors expressed in the so-called banded fruits, it was concluded that in a number of varieties there were present several factors for color; that it is possible for any color to appear pure to any extent from a small segment to the entire fruit; and that if such segregation extends to a part which may be removed and propagated vegetatively, the segregation may be perpetuated. Among the varieties of apples so propagated are Red Gravenstein, which has arisen at least twice, Red Rome, which arose three times in one orchard within the last four years, and a blood-red Spitzenberg. Many other striped or banded forms among a wide range of fruits might be listed. Attention again is called to the fact, however, that among the apples of which a study was made, no colors truly new to the variety have appeared in the somatic segregations.

As stated in the beginning, if mutations are regarded as the mere result of hybrid ancestry, then any variation which might be classed as such could be considered only as a segregation. Still there are instances of variations which do seem to be unexplainable on the basis of segregation and which certainly are not mere fluctuations. They are readily perpetuated by vegetative propagation, are decidedly distinct from the form from which they sprang, and seem to possess characters new to the individual.

The case of the green and white variegation of foliage deserves particular

consideration. It is of extremely common occurrence and generally may be observed by anyone who will spend a short time in search for it. On the campus at Corvallis there appeared on one of the several hundred bushes of Portugal laurel cultivated as an ornamental, a green and white variegation which now represents fully one-third of the entire shrub. From the green and white shoots several which are entirely white have sprung, but, as yet, none which is entirely green. The same variegation in connection with the normal plant from which it sprang, has been observed in more than a score of widely scattered species; among them red clover, maple, dandelion (Taraxacum), carnation, radish, bean, ox-eye daisy, ash, holly and Trillium. Such green and white variegations are readily propagated vegetatively. Many ornamentals also come to mind and furnish readily accessible material for study. On almost any individual it is possible to find shoots which are entirely white and frequently those which are entirely green. This behavior is clearly a case of segregation. The green shoots are readily propagated and, if left to remain on the plant from which they sprang, often outstrip the remainder of it in growth. The white form is generally vegetatively weak and usually is incapable of independent existence.

But to account for the original appearance of the "white" character. Fortunately we are in a position to know that the white exists as a recessive in some plants, as shown by Emerson in his work on maize. Chapin found, in the case of variegated Amaranthus, that seed from green branches produced green seedlings while self-fertilized seed from white branches produced white seedlings, which facts led to the conclusion that the green and white variegated plants are the result of the crossing of green and white gametes. If, then, green and white gametes exist in the case of those variegated plants (hybrids) resulting from the cross between them, the appearance of the green and the white shoots is a case of segregation resulting from hybrid ancestry. On the other hand, where the green and white forms spring directly from a form which always has been green, so far as recorded, the appearance of the white character probably would be considered as a mutation. The question arises: Is there a difference between the green and white combination which arises as a mutation and that produced by crossing green and white gametes? Whether the variegated form arises in one way or the other they are apparently indistinguishable. In either case entirely green and entirely white shoots are frequently produced in the same manner and may be similarly propagated. It is in instances of this kind that the line of demarcation between segregations and mutations is drawn only with greatest uncertainty. A further study of them may aid us also in arriving at a more definite knowledge of the nature of mutations themselves.

Double flowers from single flowers, laciniated foliage, weeping and fastigiate forms, purple foliage, and other less common variations are considered as mutations. It seems that, in general, many wide changes in the color of the flower should be classed as a segregation rather than a mutation, especially so if breeding records show the same colors among the progeny, though, even under these circumstances, how to distinguish the two absolutely is a problem, since it may be argued that the appearance of new colors among the seminal offspring may likewise be due to mutation.

Like true segregates, mutants may be perpetuated vegetatively, and scores of horticultural varieties exist. The exceptions to this rule are the pure white forms which soon perish when severed from the parent plant and may be budded or grafted into other stocks only with greatest difficulty.

SUMMARY

To sum up, then, vegetative variations are first of all of two distinct sorts —modifications or fluctuations, which do not remain true when propagated and subjected to varying conditions, and segregations or mutations which may be propagated and expected to remain reasonably constant under a

wide range of conditions. In the past experiments have largely dealt with modifications, and the conclusion reached that little or no advance could be expected from the selection of vegetative variations. There is certainly good evidence accumulating, as the work of Shamel shows, that among citrus fruits, at least, distinct advance is being made in plant improvement through bud selection alone. This is no doubt a case in which true segregates or mutants have been utilized and, if so, they can be expected to remain constant under a wide range of conditions. There is a broad field for work on the genetics of bud-variations, and when their nature is better understood and the lines of discrimination more clearly drawn between the several classes, more rapid advance in their utilization may be expected. It seems likely that many of the laws pertaining to the perpetuation of fluctuations among seminally propagated pure lines will apply with equal force to vegetative fluctuations in a clonal variety. If so, a study of the one may well be taken into consideration in connection with a study of the other in any attempt to arrive at the fundamentals underlying either. And, as suggested previously, it seems entirely possible that a closer study of the cases of vegative segregations and mutations, as they come to hand, will aid materially in the advancement of knowledge concerning the nature of variation in general and the discovery of the principles underlying it.

Alaskan Berry Hybrids

At the Sitka Experiment Station in Alaska a strain of hardy strawberries is in the making, the result of crosses between the native of the Alaskan coast region and cultivated varieties. Several thousand seedlings have been grown, all very vigorous and most of them productive and of high quality. The native variety of the interior of Alaska is now to be used in similar crosses.

The Cuthbert raspberry has been crossed with its relatives the native Salmonberry (*Rubus spectabilis* Pursh.) and the Thimbleberry (*R. parviflorus* Nutt.). The only interesting fact so far developed is that the hybrids of the two species first named are almost entirely sterile.

Report of Committee on Nomenclature

In order to determine whether any one of the three nouns, *geneticist*, *genetist*, and *genetician*, should be adopted to designate students of genetics, the undersigned committee on nomenclature of the American Genetic Association has got the opinion of a dozen of the leading philologists of the country. It finds that the form *geneticist*, which is most widely current, is favored by most of the philologists as being formed in accordance with the best usage. The form *genetist*, which has some currency, gets very little support from good etymological usage. The term *genetician*, although a hybrid, can be supported by abundant analogy; it has however, little or no currency at present.

Under these circumstances, the members of this committee unanimously intend to adhere to the form *geneticist* for their own personal use; it will also be used in all official communications of this association.

The committee realizes that usage cannot be arbitrarily established by fiat. Believing, however, that uniformity in this matter is desirable, it takes this opportunity to call the attention of all who are concerned with genetics to the fact that the term *geneticist* is worthy of general adoption, in the interests of uniformity and correct etymological practice.

(Signed) Herbert J. Webber, R. Ruggles Gates, George H. Shull, W. E. Castle, Raymond Pearl, Paul Popenoe.

The Journal of — Inheritance

HEREDITY AND SEX

Many Live-Stock Breeders Believe Disproportionate Sex-Ratios May Be Due to Inheritance—Experimental Breeding of Dr. Helen Dean King at Wistar Institute Indicates that Such is the Fact in Two Strains of Rats

UNDER ordinary conditions, for every 100 female calves born in a herd of cattle, there will be 107 male calves, the sex ratio being approximately the same as that of the human species.

To a breeder of dairy cattle it is obvious that an increase in the proportion of heifers produced would be highly advantageous. On the other hand, a large increase in the number of bulls born might be disastrous.

Miss Jessie C. Kursheedt, of New York, one of the members of this association, is interested in a herd of registered dairy cattle where about 75% of all the calves born in recent years have been bulls. She was led to think that this unfortunate state of affairs might be due to something in the heredity of the herd sire, and accordingly investigated his pedigree from that viewpoint.

It was found that he had at least two lines of ancestry in which disproportionately large number of male calves had been produced. His own sire was shown in the herd book to have fathered sixteen bulls and seven cows; while the sire's sire had seventeen bulls and thirteen cows to his credit. The herd sire's grandsire on the maternal side was found from the breed records to have sired twenty-three bulls and seventeen heifers.

While the numbers are small, and the herd book records not likely to be very accurate on this point, it can at least be said that in this pedigree a general tendency is shown to produce more offspring of one sex than of the other.

Practical breeders have often suspected that such a condition might exist. *Hoard's Dairyman* (June 25, 1915), contains the following letter from Herb. E. Sharp of the State of Washington:

"I have developed a strain of Langshan fowls that are producing over 90% females, and the trait is being transmitted from generation to generation.

"The earliest records we have of this trait were of a hen that produced about 60% females. She was accidentally bred in such a manner that the trait gradually became stronger until in the seventh generation we have hens producing from 90% to 97% females.

OTHER CASES IN CATTLE

"Have found one family of dairy cattle containing one world's record cow and her two sisters that have dropped twelve male calves and only one female. An examination of the records of the daughters of their sire, by other cows, shows that they too have inherited the trait, and are producing from 75% to 90% males.

"The males of this family, when used as herd sires, have transmitted this tendency along with other characteristics of the family, so that a preponderance of males is quite noticeable among the offspring of several herds of high quality stock.

"Certainly no man can long remain in the dairy business with a herd of cows whose calves are all bulls; a sire's value must depend entirely upon what his daughters produce in milk, butter, and calves; and the sire, whose daughters drop nothing but male calves, no matter what their milk and butter records may be, will put his owner out of business or compel him to buy a complete new herd of cows in a few years."

"In 1912, I mated twelve hens to one cock bird. He was very vigorous, and as he had the entire liberty of the yard where they were all confined, we can safely presume that he would find practically all the hens

when they first came into the season. Now if there were anything at all in the theory advanced that the time of mating controls the sex of the offspring, a large proportion of these females must have performed in a nearly uniform manner, as all were under practically identical conditions or as nearly as possible to secure.

"There were not two hens that performed in an identical manner, and there was not even an approximate uniformity in their performances. One hen produced all males, another produced all females, and the rest, each seemed to take her own course in various degrees between these two extremes; some of the hens were mated again to the same male, and some to other males the following year, while some were discarded.

"All those retained in the breeding pens the next year, regardless of the influence of the various males, repeated their former year's work with some very slight variations. The hen that raised all females, after three years' work, finally raised one cockerel, but he came after she had produced sixty pullets.

"Five of her daughters were then tested and produced seventy-five pullets and two cockerels. In this family the sex tendency is strong enough to be transmitted, and in any family the individual that is strong enough to transmit his sex tendencies, certainly has greater power to transmit than the individual that cannot transmit sex tendencies and as a sire's value depends on what he transmits, then the sire that transmits sex tendencies, especially a tendency to a predominating number of females, is of vastly greater value than the sire without this power or with a tendency towards a predominating number of males.

"Some one said: 'Your bull may be losing $6,000 a year for you,' but I know a whole family of bulls that carry world's record blood in their veins that are putting their owners out of the dairy business at a rapid rate, not even suspected by their owners, and these bulls sold for over a thousand dollars each."

The editor of *Hoard's Dairyman* properly comments on this letter, that the amount of time through which Mr. Sharp's breeding experiments have been carried is not enough to furnish conclusive proof. A breeding experiment well known to geneticists has been carried on for six years under the most careful conditions, however, and has given results which lend some color to the belief that one may get a strain of animals that has a tendency to produce disproportionate numbers of one sex.

This is the inbreeding experiment of Dr. Helen Dean King at the Wistar Institute, Philadelphia, in which more than 22,000 albino rats have been bred and studied. Although Dr. King has not yet published her results, it is possible here to state the general trend of the experiment.

In the rat, the normal sex ratio happens to be the same as in man and cattle, namely, 107 males to 100 females. Dr. King began her work by taking from the stock animals one healthy litter of new-born rats, two males and two females. The descendants of one pair of the rats have, after the sixth generation, all come from the mating of brother and sister from litters in which males invariably predominated. This is the A or male line. The B or female line of her experiment came from the other pair of the original litter and has been obtained by mating brothers and sisters from litters containing (after the sixth generation) an excess of females. In the first six generations no selection for sex was made, the object being to get the stock well-established and homogeneous.

All of the 22,000 rats used are therefore descendants of one or other of the two pairs in the litter first picked out for the foundation of the experiment, and in the two strains there has been, since the sixth generation, steady selection in the opposite directions, through twenty-one generations, with strict inbreeding of the animals selected.

By this process, the tendency to produce a disproportionate number of one sex appears to have been fixed in

each line of descent. The result is, that instead of a normal ratio of 107 to 100 (which was established for this particular stock at the beginning of the experiment, by ascertaining the sex ratio in 1,000 newborn litters), Dr. King now gets in various generations ratios as far apart as 150 males to 100 females, in the male producing line, and sixty-five males to 100 females, in the female producing line.[1]

If such a state of affairs can be reached under the carefully controlled conditions of a laboratory, it is not a rash assumption to suppose that it might occasionally be reached unknowingly in the herd of a practical breeder.

IN LIVESTOCK INDUSTRY

Whether such conditions actually prevail in the livestock industry cannot definitely be told except after thorough examination of the records of that industry. This would offer numerous difficulties. In the meantime, with the analogy of Dr. King's experiments on rats, any breeder whose herd sire is producing mainly bull calves, and who finds that such a tendency marks the ancestry of the animal in question, might well feel justified in getting a new herd sire with a more auspicious record.

Finally, can such a peculiar sort of heredity as Dr. King has found, be brought into line with what is at present known or suspected regarding sex-determination?

There are numerous ways in which it can be explained, without resorting to anything mystical. Dr. King has not yet attempted to offer a definite explanation, but suggests that it may be due to such a simple cause as differences in the permeability of the eggs. It will be recalled that there are probably two kinds of spermatozoa in the rat, one of which is male-producing and the other female-producing. As these are apparently produced in equal numbers, it is evident that, since there is seemingly only one kind of ovum, the number of young of each sex produced would of necessity be equal, unless some outside cause intervenes.

It is further evident that if the eggs of a given female were, for some reason, more easily penetrated by male-producing than by female-producing sperms then that female would tend to produce an excess of male offspring. If the condition were reversed, she would produce an excess of females.

It requires no strain of the imagination to suppose that a race of rats might be developed, in which there was a hereditary tendency in the eggs to be penetrated more easily by one kind of spermatozoa than by the other. If so, the sex-ratios which have resulted from Dr. King's breeding experiments would be easily explained.

Whether that is the actual explanation in this case, and whether some similar explanation also applies to the cases which seem to have been found in cattle and fowls, one cannot now say. But regardless of explanation, the observed facts seem reasonably certain, namely, that it is possible for a tendency to produce disproportionate numbers of one sex of offspring to be hereditary in rats, and perhaps in other animals.

[1] Dr. King notes that she "cannot in any case predict the sex ratio in an individual litter, since not infrequently the two litters of one female will each contain an excess of males while the litters of a sister rat, mated to the same brother, will both contain an excess of females. It is only when we take averages for a large number of individuals that we get the results as indicated. The average sex ratio for the entire A series is 125 males to 100 females; that for the B series is only eighty-three males to 100 females." The deviation from the usual ratio has been in the same direction, in each line, in every generation except one. The tenth in the A line and the seventh in the B line are the exceptions.

TWO PHEASANT CROSSES

Reciprocal Matings Give Widely Different Results in Female and Identical Results in Male Offspring—Females Practically Sexless—Possibility of Sex-Linkage as Explanation

JOHN C. PHILLIPS, *Wenham, Mass.*

IN THE *American Naturalist* for 1913 (p. 701), the writer described a reciprocal first cross between Reeves' pheasant and the common ring-neck pheasant (*P. torquatus*). It was shown that the males differed very perceptibly in the two crosses, but of the females nothing could be learned because only one female was reared from the cross of male ring-neck female Reeves, and none at all in the other cross.

In order to find out whether these sterile reciprocal hybrids *always* differed in the male sex, and also whether the females would show any differences, another cross was carried out in 1914 as a check upon the first experiment. But in the second experiment the Prince of Wales pheasant (*P. principalis*) was used instead of the *P. torquatus*.

The *P. principalis*, a distinct species of true pheasant, belongs to the dark-necked, red-rumped group, and has been used in another cross by me. (See Jour. Exp. Zool., Vol. 18, p. 93.) The striking features of the male are briefly as follows: neck-ring absent, lesser and median wing coverts white, with white shaft stripes on greater coverts; rump and upper tail coverts orange red, with a few fine black dots; tail barring reduced to faint lines. On the other hand, *P. torquatus* differs markedly in these four points, as follows: white neck-ring well marked; rump greenish to greenish slate, with subterminal bars of brilliant green; lesser and median wing coverts mostly sandy-buff color; tail barring very marked, especially towards the tip, where black areas 6 to 12 millimeters wide occur. There are other differences which need not be mentioned here The female of *P. principalis* is much lighter colored than the *torquatus* female, but otherwise very similar, and the two species produce fertile hybrids.

REEVES PHEASANT

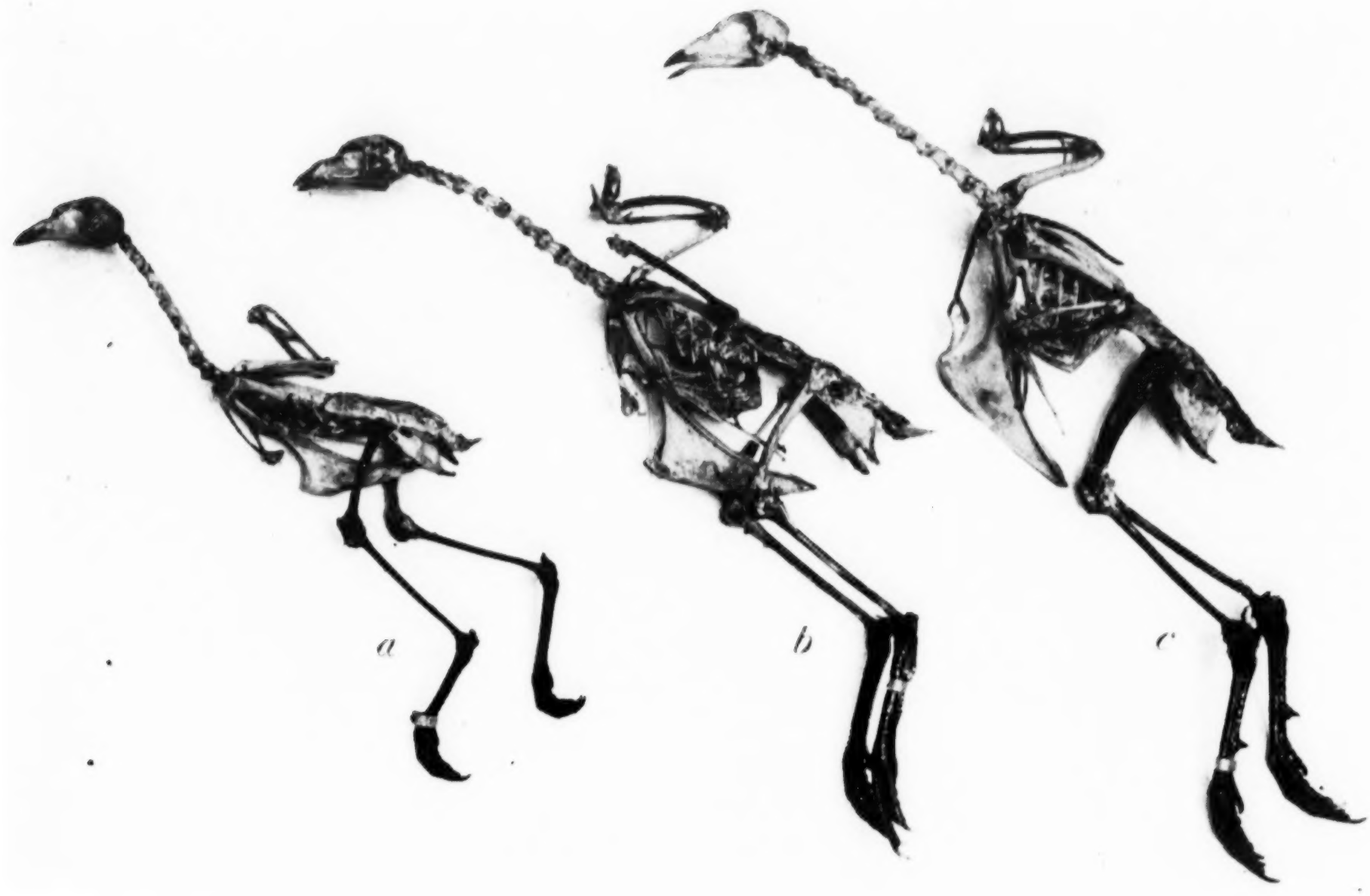
The Reeves pheasant, *Syrmaticus reevesi*, a familiar aviary species, is a wholly different looking bird, and belongs to a monotypic genus. The male is entirely unlike any of the true pheasants (*Phasianus*) in coloring, and has a tail 3 or 4 feet long. The upper surface of the body is bright golden color, with black edgings to the feathers of the mantle, back and rump, while the breast and flanks are barred with white, black, and chestnut. The head is strikingly marked with black and white. The female Reeves pheasant is also unlike any true pheasant, and shows some of the male characters in her face pattern and the colors of her mantle, breast, and flanks.

In this cross, therefore, we have to do with two species, not only different in the male sex but wholly unlike in both sexes and in all plumages, and always producing absolutely sterile hybrids.

In 1914, a Reeves cock was mated with two Prince of Wales females (Pen J 1914), and a Prince of Wales cock was placed with a couple of Reeves females (Pen K 1914). It may be remarked that both these parent stocks were inbred and came from the same grandparents. Large numbers of *P. principalis* have been reared here and no variations noticed.

From Pen J nine birds were reared to maturity, four males and five females, and from Pen K, one male and three females. A wandering cat somewhat curtailed the experiment.

Comparing the two pens of males and the two pens of females, we get the fol-



DIFFERENCES IN SIZE OF HYBRID PHEASANTS

The small skeleton (*a*) at the left is that of a female from the cross of a Reeves male pheasant and Prince of Wales female; while in the middle (*b*) is the female of the reciprocal cross, namely, Prince of Wales male and Reeves female. It is obvious that the latter cross produces a much larger bird, though the parentage in each case is the same except in the matter of sex. At the right (*c*) is a male from either cross, the results being practically identical in that sex. (Fig. 2.)

lowing result: Males from J and K alike, as far as can be determined, but females from J differ from those in K in size and color. To explain more fully let us take up these three points:

Size.—The five J females are uniformly small. They feathered late and were always lacking in flesh and vigor. The skeleton is extremely light (see fig. 2, A), and smaller in every dimension than its fellow of the opposite cross (fig. 2, B). Their tails are short and Reeves-like. They are also much smaller than other Reeves or principalis females.

THE RECIPROCAL CROSS

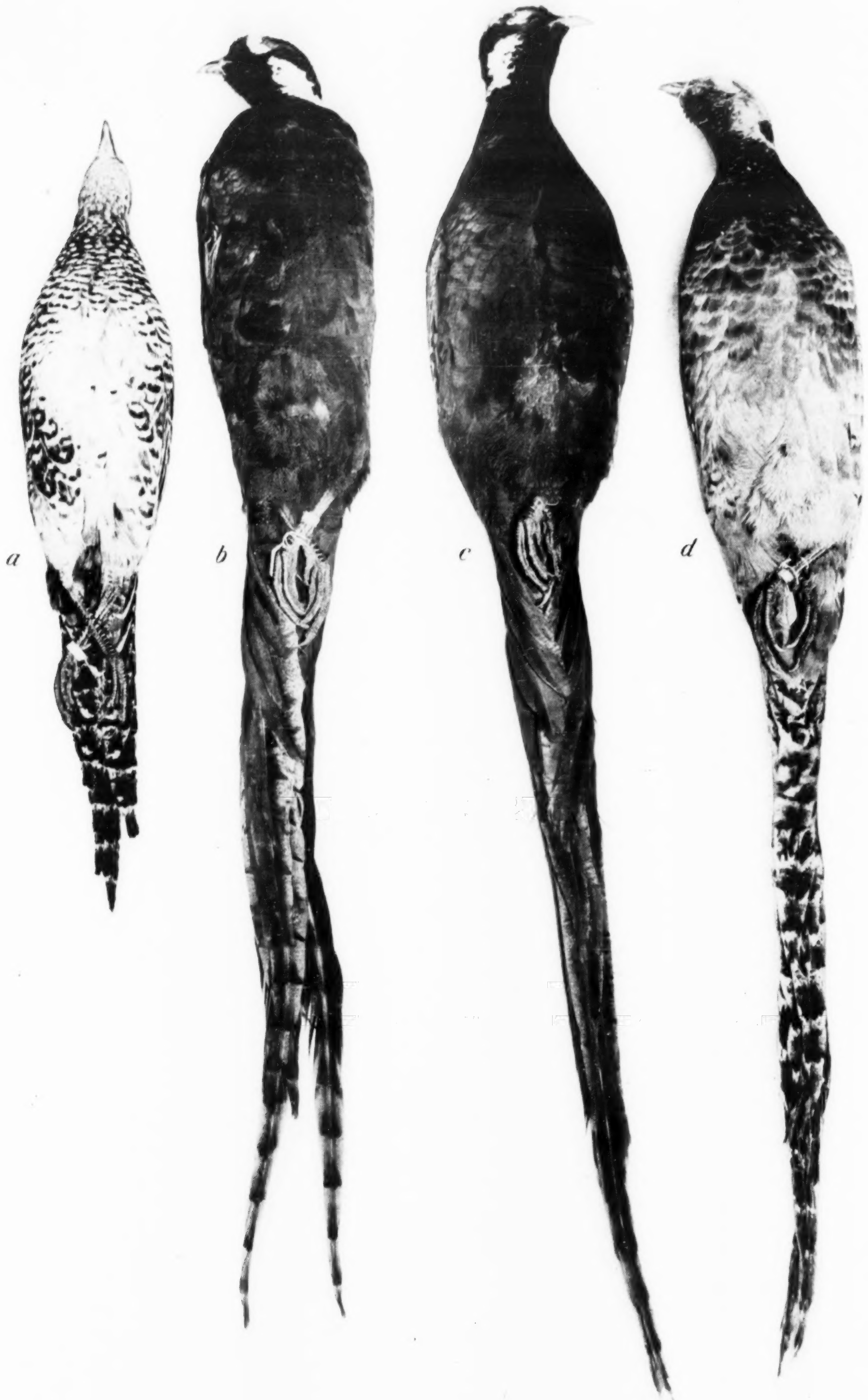
The three K females, on the other hand, are large heavy birds with long tails, male-like actions, and in two cases well-developed spurs. The plate shows them to be nearly as large as the male birds and with tails fully as long. The individual whose skeleton is figured did have spurs (fig. 2, B). They are far larger than the females of either of the parent species.

Plumage.—The color differences are fully as remarkable as those of size. The J females are all alike or very nearly so, and extremely similar to Reeves females. The photograph of the skins shows well the barred appearance of breast and flanks, the chestnut mantle and the greyish back and rump.

On the other hand, the K females are extremely male-like, especially in the markings about the head which in No. 1543 are even more sharply contrasted than in the specimen shown in the plate (No. 1542). They are, essentially, washed-out, coffee-colored imitations of their brother hybrids and were supposed to be males until they were dissected. They differ a little, individually, in the intensity of their coloration, and in the development of the male face pattern. The most extreme, or most Reeves-like,

PLUMAGE DIFFERENCES IN RECIPROCAL CROSSES

In the center are males from the two crosses, which are as much alike as one would expect to find two brothers. At the sides are the females from the same two crosses—here we at once see wide contrasts, in practically every point examined. (*a*) is female hybrid from the cross of male Reeves pheasant with female Prince of Wales; (*b*) is male hybrid from the same cross; (*c*) is male hybrid from the cross of male Prince of Wales and female Reeves, while (*d*) represents the female hybrid from the cross of Prince of Wales male and Reeves female. (Fig. 3.)



VENTRAL VIEWS OF THE HYBRIDS

The same birds photographed in fig. 3 are here shown, turned over. The males are seen to be as much alike below as above, while the differences between the females are even more striking in this aspect. Arrangement of birds is the same as in the preceding cut, as follows: (*a*) female hybrid from cross of Reeves male and Prince of Wales female; (*b*) male hybrid from the same cross; (*c*) male hybrid from cross of male Prince of Wales and female Reeves; (*d*) female hybrid from the latter cross. (Fig. 4.)

No. 1543, has a black patch on the throat and another on the nape, while the auriculars are blackish and the intermediate region of face and neck white or buffy. The tails are all barred, but not coarsely, while the narrow black streaks on the rump show well the pattern of the principalis male. These birds, therefore, show very little influence of the Reeves female. Comparing them with our one female specimen from male ring-neck x female Reeves, the corresponding cross made in 1912, they appear entirely different. This female (No. 448) has no trace of male plumage. She corresponds very closely to the J females of 1914, but she is much larger than any of them.

FEMALES ARE SEXLESS

Sex Glands.—Perhaps the greatest surprise of all was the failure to find any trace of germinal tissue in any of the females of either cross. All suspicious tissue from the proper region was fixed and sectioned, but the results have been entirely negative. These sexless birds are called females on the strength of a small and flaccid oviduct, normally placed and present in all cases.

Turning to the males, I find that there is no trace of a reciprocal difference as occurred in the Reeves x ring-neck cross of 1912. Both crosses are darker in color than the darkest cross of 1912 (male ring-neck x female Reeves). This fact may be explained by the generally darker tone of Prince of Wales males as compared with ring-neck males. The tails are always barred, unlike the male Reeves x female ring-neck cross of 1912. The ground color of the central tail feathers is darker than that of the 1912 cross and the backs, scapulars and rumps are more uniform. No other differences are apparent, the presence or absence of neck-ring having no apparent effect on the pattern of the hybrids.

All the males of the 1912 and of the 1914 crosses are similar in size. The reciprocal difference of male plumage described for the 1912 cross is trifling as compared with the wide size and pattern differences in the females of the 1914 cross.

Summary.—In the 1914 cross, Reeves male x Prince of Wales female (cross J) and in the reciprocal cross Prince of Wales male x Reeves female (cross K), the sterile male hybrids are similar and closely approximate the slightly different reciprocal hybrids of the Reeves x ring-neck experiment of 1912. With the females, however, of the two first-mentioned crosses, there are almost no points in common. In cross J they are shown to be small, female-like, and very close to the Reeves female in their coloring. In cross K they are large and male-like, with pattern and coloring of both the male parents. No trace of a sex gland was found in any of these females, but a small and thin-walled oviduct was always present.

These facts are simply given for what they are worth. The writer does not feel competent to enter into a discussion of their possible significance. It is possible that they may be explained on the basis of sex linkage, with the assumption that the eggs are dimorphic and the sperms monomorphic for sex and sex linked characters, but no proof is available on account of the impossibility of testing the sterile hybrids.

The most suggestive point about these hybrids seems to the writer to be the Reeves-like appearance and puny size of the females when the male Reeves was used as a parent. It would almost seem as if gametes bearing Prince of Wales characters had been kept apart in producing these females. Their extremely small size led to a question as to the size of their somatic cells. Rough measurements of their spleen cells made for me by D. H. Wenrich failed to reveal any difference of this sort between K and J females. Obviously the chromosome count would be of great interest in this case also. The absence of ovarian tissue is another curious feature which demands further experiment to verify completely.

MENDELISM UP TO DATE

A REVIEW

IT IS just half a century since the Austrian monk, Gregor Mendel, published in a provincial journal the results of his now famous breeding experiments with garden peas. They lay unnoticed until 1900, when three other breeders whose work had led them to similar conclusions, almost simultaneously turned up the work of Mendel and gave it to the world.

Breeding along the lines marked out by Mendel at once became the most popular method of attack, among those who were studying heredity. It is largely responsible for the creation of a new science—genetics.

During the past fifteen years, hundreds of thousands of plants and animals have been bred under carefully controlled conditions by men interested in repeating and extending Mendel's conclusions. The publications on the subject are for the most part brief, widely scattered, and almost meaningless to one who is not in the current of Mendelian research. This has prevented many persons from appreciating the progress of that research in its broad outlines. The present status of it is now set forth by Professor T. H. Morgan of Columbia University, and three of his associates,[1] under the title of "The Mechanism of Mendelian Heredity," their account being based principally on their own work.

Professor Morgan fears that zoologists and botanists are tending to look on genetics as a field apart, with which they have no direct concern. He believes that this is a mistaken attitude; that every biologist needs a knowledge of genetics; and it is to provide the members of the profession with a succinct account of what they need to know about this science, he says, that he and his students have written the present book.

One of the useful functions of the volume should be to bring home to readers who have a little knowledge of genetics a realization of the fact that the term "Mendelism" is nowadays used to cover a number of distinct and, in their details, often irreconcilable views. Professor Morgan's Mendelism would hardly be acknowledged as such by many who think themselves Mendelists; and other students have advanced speculatively in certain directions even farther from the base than he has.

PROGRESS IN MENDELISM

To put the matter very frankly, we will have to consider that a large part of the so-called "Mendelism" which is current at present is in some way out of date. This is perhaps particularly true of the views held by the rank and file of eugenists, who are obliged to work with a material that is in many ways unsuitable for genetic analysis, and whose exposition of Mendelian heredity rarely fails to provoke a smile of pity from the advanced student in the subject. A considerable part of the students of genetics are, judged by the present book, behind the times, and working with hypotheses that, according to the authors, will not stand in the light of some of the recent laboratory work. The cause of this state of affairs is undoubtedly due mainly to the fact that it has been impossible for students to get a comprehensive account of recent developments in the science; they were seeking for light, but none was given them.

It is likely, then, that they will welcome the illumination of Dr. Morgan and his co-authors.

Before we analyze their views, however, let us try to get clearly in mind the fundamentals of that type of heredity known as Mendelian.

[1] The Mechanism of Mendelian Heredity, by T. H. Morgan, Professor of Experimental Zoology, Columbia University; A. H. Sturtevant, Cutting Fellow, Columbia University; H. J. Muller, Assistant in Zoology, Columbia University; C. B. Bridges, Fellow in Zoology, Columbia University. Pp. xiii+256, figs. 64; bibliography. New York, 1915, Henry Holt and Company.

Inherited differences in individuals, it will be admitted, are due to differences in their germ plasms. It is convenient to think of these differences in germ plasms (that is, differences in heredity) as being due to the presence in the germ plasm of certain hypothetical units, which are usually referred to as *factors*. The factor, nowadays, is the ultimate unit of Mendelian research.

Each of these factors is considered to be nearly or quite *constant*,—that is, it undergoes little, if any, change from generation to generation. It is not "contaminated" by other factors with which it may come in contact in the cell. This is the idea which gives rise to the phrase "purity of the germ cells."

The first fundamental principle of Mendelism, then, is the existence of relatively constant units, the Mendelian unit-factors, as the basis for transmission of all the traits that go to make up an animal or plant.

ALLELOMORPHISM

From experimental breeding we find reason to believe that each factor has one or more alternatives, which may take its place in the mechanism of heredity, thereby changing the visible character of the individual plant or animal in which it occurs. To put the matter a little differently, one germ cell differs from another in having alternatives present in place of some of the factors of the latter. A given germ cell can never have more than one of the possible alternatives of each factor.

These alternatives of a factor are called its allelomorphs.

Now a mature germ cell has a single system of these factors; but when two germ cells unite, there result from that union two kinds of cells—namely, immature germ cells and body cells; and both these kinds of cells contain a double system of factors, because of course they have received a single entire system from each parent. This is the second of the fundamental principles of Mendelism: that the factors are single in the mature germ cell, but in duplicate in the body cell (and also in the immature germ cell).

In every cell with a double system of factors, there are necessarily present two representatives from each set of allelomorphs, but these may or may not be alike—or in technical language the individual may be homozygous, or heterozygous, as regards the given set of alternative factors. Looking at it from another angle, we see a *single* visible character in the plant or animal, but it is produced by a *double* factor in the germ plasm.

When the immature germ cell, with its double system of factors, matures, it throws out half the factors, retaining only a single system; and the allelomorphic factors which then segregate into different cells are, as has been said above, uninfluenced by their stay together.

But the allelomorphic factors are not the only ones which are segregated into different germ cells, at this maturation of the cell; for the factors which are not alternative are likewise distributed, more or less independently of each other, so that it is largely a matter of chance whether factors which enter a cross in the same germ cell, segregate into the same germ cell or different ones, in the next generation. This is the next fundamental principle of Mendelism, usually comprehended under the term "segregation," although, as has been pointed out, it is really a double process, the segregation of alternative factors being a different thing from the segregation of non-alternative factors.

From this fact of segregation, it follows that as many kinds of germ cells can be formed by an individual, as there are possible combinations of factors, on taking one alternative from each pair of allelomorphs present. In practice, this means that the possible number of different germ cells is almost infinitely great, as would perhaps be suspected by anyone who has tried to find two living things that are just alike.

THE ESSENCE OF MENDELISM

Such is the essence of Mendelism; and the reader is probably ready to admit that it is not a simple matter, even when reduced to the simplest terms. To sum up, the principal fea-

tures at the base of the hypothetical structure are these:

1. There exist relatively constant units in the germ plasm.

2. There are two very distinct relationships which these units may show to each other. Two (or more) unit factors may be alternatives in the mechanism of inheritance, indicating that one is a variation (or loss) of the other; or they may be independent of each other in the mechanism of inheritance.

3. The mature germ cell contains a single system of independent factors (one representative from each set of alternates).

The immature germ cells, and body cells, have double systems of independent factors (two from each set of alternatives).

4. The double system arises simply from the union of two single systems (*i. e.*, two germ cells), without union or even contamination of the factors involved.

In the formation of a single system (mature germ cells) from a double (immature germ cells), pairs of alternates separate, passing into different germ cells. Factors not alternates may or may not separate—the distribution is largely a matter of chance. This chance distribution is more or less disturbed by the phenomenon of linkage, which will be described later in this review.

INFLUENCE OF WEISMANN

Such are the fundamental principles of Mendelism; but on them was early grafted a theoretical structure due mainly to the German zoologist, August Weismann. To understand his part in the story, we must advert to that much-mooted and too often misunderstood problem furnished by the *chromosomes*.

These little rods of easily stained material, which are found in every cell of the body, were picked out by Weismann as the probable carriers of heredity. With remarkable acuteness, he predicted their behavior at cell-division, the intricate nature of which is usually the despair of every beginner in biology. When Mendelian breeding, in the early years of this century, showed temporary pairing and subsequent separation of units in the germ cell, it was soon realized that the observed facts of breeding fitted to a nicety the observed facts (predicted by Weismann) of chromosome-behavior; for at each cell-division the chromosomes, too, pair and separate again. The observed behavior of transmitted characters in animals and plants followed, in so many cases, the observed behavior of the chromosomes, that many students found it almost impossible to believe that there was no connection between the two, and Weismann's prediction, that the chromosomes are the carriers of heredity, came to be looked on as a fact, by many biologists.

But when this much of Weismann's system was accepted, other parts of it went along, including a hypothetical system of "determiners" in the chromosome, which were believed to determine the development of characters in the organism. Every trait of an animal or plant, it was supposed, must be represented in the germ-plasm by its own determiner; one trait, one determiner. Did we find a notch in the ear running through a pedigree? Then it must be due to a determiner for a notch in the ear in the germ-plasm. Did we find mathematical ability hereditary? Then there must be a determiner, the expression of which was mathematical ability.

For a while, this hypothesis was of service in the development of genetics; some students even began to forget that it was a hypothesis, and to talk as if it were a fact. But the exhaustive tests of experimental breeding of plants and animals have long caused most of the advanced students of genetics to drop this simple hypothesis.

In its place, we have the *factorial hypothesis*, evolved by workers in America, England, and France at about the same time, and of which the work of Morgan and his associates at Columbia University is one of the solid bases. It is the hypothesis accepted by a majority of the leading American geneticists at the present day; unfortunately it is scarcely apprehended by many who are not actively working in genetics, and

a few who are. Eugenists, for example, almost to a man have failed to adopt this hypothesis.

FACTORS ARE NUMEROUS

They tend to cling to the old Weismannian idea of one determiner for each visible "unit character." Morgan and most of the advanced students of the subject declare flatly that such an idea is, in the light of recent research, absolutely untenable. In place of it they have adopted the hypothesis that each visible character is due to the cooperation of an indefinitely large number of factors in the germ-plasm; and conversely, that each single one of these factors produces an influence on an indefinitely large number of traits.

It is of the utmost importance that this hypothesis should be understood, for it is the basis of a large part of the work in genetics today. Those who accept it must give up talking about, *e. g.*, Roman nose being due to a determiner for Roman nose in the germplasm. The modern view would say that the "Romanness" of the nose is due to the interaction of a very large number of factors, each of which, in turn, is also probably influencing an indefinitely large number of other characters in the body.

This is not a mere speculative hypothesis—the authors look on it as almost a demonstrated fact. For example, the little pomace fly, Drosophila, which they have been breeding in immense numbers, has normally a red eye. At an earlier day it would have been assumed that it possessed some determiner which caused the color of the eyes to be red. But in the course of the breeding, as many as twenty-five distinct mutations in this eye color have come to light. It is, therefore, their assumption that at least twenty-five different factors are concerned in the production of this red eye color, and that when a single one of these factors changes, a different end result is produced, such as pink eyes, or vermilion eyes, or white eyes, or eosin eyes.

"Each such color may be the product of twenty-five factors (probably of many more) and each set of twenty-five or more differs from the normal in a different factor. It is this one different factor that we regard as the 'unit factor' for this particular effect, but obviously it is only one of the twenty-five unit factors that are producing the effect. However, since it is only this one factor and not all twenty-five which causes the difference between this particular eye color and the normal, we get simple Mendelian segregation in respect to this difference. In this sense we may say that a particular factor (*p*) is the cause of pink, for we use cause here in the sense in which science always uses this expression, namely, to mean that a particular system differs from another system only in one special factor.

EFFECT OF ONE FACTOR

"The converse relation is also true, namely, that a single factor may affect more than one character. For example, the factor for rudimentary wings in Drosophila affects not only the wings, but the legs, the number of eggs laid, the viability, etc. Indeed, in his definition of mutation, De Vries supposed that a change in a unit factor involves all parts of the body. The germ-cells may be thought of as a mixture of many chemical substances, some of them more closely related to the production of a special character, color, for example, than are others. If any one of the substances undergoes a change, however slight, the end product of the activity of the germ-cell may be different. All sorts of characters might be affected by the change, but certain parts might be more conspicuously changed than are others. It is these more obvious effects that we seize upon and call 'unit characters.' It is the custom of most writers to speak of the most affected part as a 'unit character,' and to disregard minor or less obvious changes in other parts. They frequently speak of a unit character as the result of a unit factor, forgetting that the unit character may be only one effect of the factor."

It is hardly necessary to insist on the far-reaching practical importance of this changed viewpoint. Nor is it necessary to insist on the slight degree to which it has so far been apprehended

by the public, for a glance over the great body of semi-popular writings on genetics, particularly as concerned with man, will show that the primitive and charmingly simple idea of "one character, one determiner" still prevails.[2]

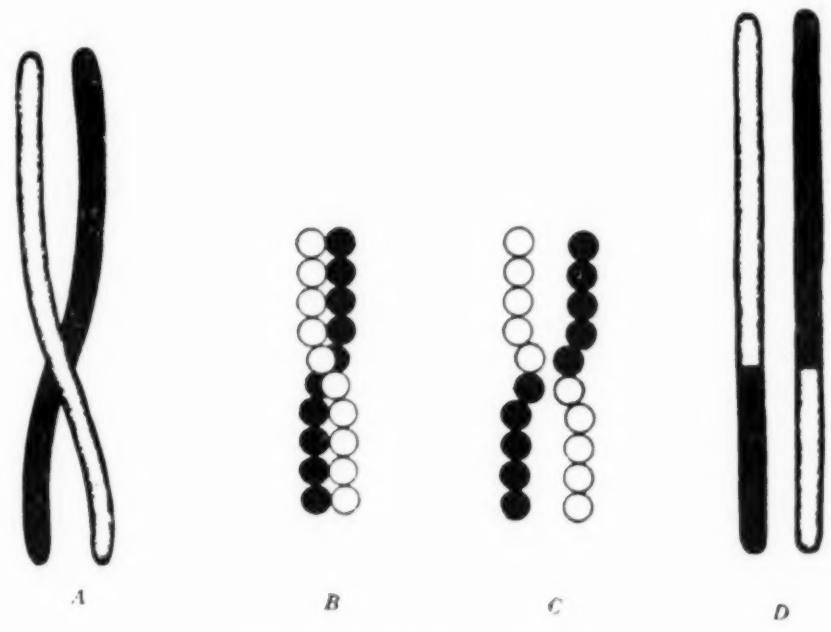
In addition to this fundamental revision of the hypothesis by which the observed facts of Mendelian heredity are explained, we have some extensions that are of great importance. The first to be considered here is connected with the now widely-accepted hypothesis that the chromosomes furnish the basis for Mendelian heredity.

With the adoption of this hypothesis, it was obvious from the beginning, as the authors point out, "that there was one essential requirement of the chromosome view [of heredity], namely, that all the factors carried by the *same* chromosome should tend to remain together. Therefore, since the number of heritable characters may be large in comparison with the number of pairs of chromosomes, we should expect actually to find not only the independent behavior of pairs, but also cases in which characters are linked together in groups in their inheritance. Even in species where a limited number of Mendelian units are known, we should still expect to find some of them in groups."

LINKAGE OF FACTORS

Bateson and Punnett, in 1906, made the discovery which according to Morgan meets this need; the phenomenon is now called *linkage*. Its importance in the theory can be understood from the fact that in the fruit-fly (Drosophila), the principal material for work at Columbia University, more than a hundred separate factors have been studied in heredity, and they have been found to be linked together in only four systems (corresponding to the four chromosomes of the fly), one of which contains, so far as is now known, but two factors.

After it was found that factors were linked together the question naturally arose, Do they always remain linked, or do they sometimes break away and form new combinations? Experimental breeding has shown that the latter is the case. Another item is therefore added to the outline of Mendelism: *crossing over*, in which a character leaves the group to which it is normally linked, and unites with the alternative group. This behavior can be plausibly explained through the chromosome mechanism; for at one period in their history the chromosomes unite and then split. It is evident that a crossing over of various factors might be quite possible at this time.



CROSSING OVER

Diagram representing the way factors may cross from one chromosome to another. At the level where the black and white rod cross at (*a*) they fuse and unite separating as shown in (*d*). The details of the crossover are shown in (*b*) and (*c*). From Morgan et al. (Fig. 5.)

Starting with this fact of crossing over the authors reached another conception, which is one of the newest developments in heredity and which seems to give us such a precise knowledge of this phase of inheritance that many workers contemplate it aghast, holding their breaths and hardly daring to believe that we can have traveled so far in the exploration of a territory that was not long ago thought pathless. This conception which has been lately introduced by Morgan and his associates is that of the *linear arrangement* of factors.

[2] It is worth noting that a large part of the attacks on Mendelism are based on this older interpretation of it. When critics prove to their own satisfaction, in many pages of evidence, that the idea of "one character, one determiner," which they consider to be Mendelian, is perfectly monstrous, the advanced Mendelist merely smiles and agrees with them. The factorial hypothesis is untouched by most of the shots at "Mendelism" in general.

The curious and definite facts which have led to this conception must be dealt with in explaining heredity by any hypothesis, but seem to fall in exactly with the chromosome hypothesis which is adopted by the authors. We start with the idea that the factors are carried in the chromosomes, and that from time to time they cross over from one to another, after the manner diagramatically shown in Fig. 5. When the relative frequency of the occurrence of the various possible crossovers was tabulated it was found that they were made with a certain regularity, which was hardly compatible with the idea that the factors were swimming around at large in the chromosome, or that they changed places without any provocation. It was found almost necessary to assume that they had definite stations, that each factor was regularly located at a certain definite point in the chromosome.

PROOF OF LINEAR ARRANGEMENT

That assumption is exactly what the authors have made; and, as they have had a great number of cases of crossing over to study, they have been able actually to draw a map of the four chromosomes possessed by Drosophila, and to locate in them the various traits which they have studied. The correctness of their map can be tested in a very ingenious way:

"The chance that such a process of crossing over will occur between any two given points on the chromosome should obviously be greater, the greater the distance between these points. If then the Mendelian factors lie along the chromosome, the amount of crossing over between any two of them will depend on their distance apart. Should two points lie near together a crossover will only rarely occur between them; if they lie further apart the chance of such a crossover taking place at some point between them will be greater. From this point of view the percentage of crossing over is the expression of the 'distance' of the factors from each other."

In other words, this is a case where we can ask, and receive, definite mathematical evidence to support the idea of linear arrangement. We need only examine the behavior of a group of factors that are not too far apart. If we find that factors A and B are crossing over four times in a hundred opportunities, while factors B and C are giving twelve crossovers in the same number of chances, then we should expect to find that the number of crosses of A and C is either the sum or the difference of these two numbers—*i. e.*, sixteen or eight—depending on whether C lies to the one side or the other of A and B. Having ascertained the relative position of C, we then go on to D, E, and all the other factors that we find in the group, and which are fairly close together—for if they are far apart, the crossing over will be disturbed, for reasons that need not be described here. The authors say that they have actually got the definite numerical results expected, and these have enabled them to draw the chromosome map which they print as a frontispiece.

The idea of linear arrangement of the factors, it should be added, depends at present almost wholly on the work of the authors, few other geneticists having suitable material for testing it. The authors have shown that it fits some of the results obtained by Bateson and his associates, which were explained by those experimenters on a different basis.

It is not possible here to discuss any of the other conceptions of Mendelian heredity, which the authors describe, but enough has perhaps been said to make the reader realize that the modern ideas of Mendelian heredity, differing widely from the earlier ideas which went under the same name, are decidedly complex, but exact.

Just how far are they facts, and how far theories, the reader may well ask. It can only be replied that beyond the observed results of hybridization, all is hypothesis. Many who are engaged in the study of heredity do not even accept the hypothesis that the chromosomes are the carriers of the substances or factors which lie at the base of heredity.

Nevertheless, Dr. Morgan is unquestionably correct when he remarks in the preface that the view set forth in the book, a few features of which have been glanced at in this review, is the

view held by a large number of those who have gone most deeply into the subject.

"Exception," he continues, "may perhaps be taken to the emphasis we have laid on the chromosomes as the material basis of inheritance. Whether we are right here, the future—probably a very near future—will decide. But it should not pass unnoticed that even if the chromosome theory be denied, there is no result dealt with in the following pages that may not be treated independently of the chromosomes; for, we have made no assumption concerning heredity that cannot also be made abstractly without the chromosomes as bearers of the postulated hereditary factors. Why, then, we are often asked, do you drag in the chromosomes? Our answer is that since the chromosomes furnish exactly the kind of mechanism that the Mendelian laws call for, and since there is an ever-increasing body of information that points clearly to the chromosomes as the bearers of the Mendelian factors, it would be folly to close one's eyes to so patent a relation. Moreover, as biologists, we are interested in heredity not primarily as a mathematical formulation but rather as a problem concerning the cell, the egg, and the sperm."

To this the reviewer can add that the chromosome view appears to have gained ground in America during the past year or two, among these who are most competent to hold an opinion on the subject; and that despite the strong opposition of some biologists of note, no alternative explanation has been put forward which has met with any except a limited acceptation.

Finally, to sum up the main features of the mechanism of Mendelian heredity, as understood by the authors of the book under discussion, and many other geneticists, we find among our ideas the following:

1. That the various characters which make up the physical constitution of any individual plant or animal are due to the action (concurrently with the environment, of course) of what we term, for convenience, factors, separable hypothetical units in the germ-plasm, capable of independent transmission.

2. That each visible character is due to the cooperative action of an indefinitely large number of factors (for such a simple creature as the fly Drosophila, there may be ten or twenty millions); conversely, that each of these factors affects an indefinitely large number of characters.

3. That these factors, or their material bases, are passed from one generation to another in certain bodies called chromosomes, in the egg and sperm.

4. That the factors are generally linked together in groups, each chromosome having a group of its own; that they are arranged along the chromosome in a linear series, but sometimes change places with each other by "crossing over." To these propositions there are a number of corollaries which cannot here be mentioned.

If the conclusions above listed stand the test of time in anything like their present form, genetics can well challenge every other science to produce a greater body of results in fifteen years.

High Fecundity in Hens Not a Unit Character

An editorial footnote attached to Slocum's article on poultry breeding in the November issue of the JOURNAL OF HEREDITY (p. 485) unintentionally misrepresented the work of Dr. Raymond Pearl and the Maine Experiment Station, by stating their conclusions to be based on the belief that high egg production in hens is a unit character. This statement was entirely incorrect. Dr. Pearl has presented data in several papers to show that fecundity in poultry is a character influenced by at least three separate and distinct heritable factors. He has never stated that he thought it a unit character.

SAVING THE KOKIO TREE

Wild Relative of Cultivated Cottons Becomes Nearly Extinct in Hawaii, But is Rescued For Plant Breeders—May Be of Value in Hybridization—Other Species Similarly Threatened

ROBERT A. YOUNG
Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, Washington, D. C.,
AND THE EDITOR

WHEN Captain Cook discovered the Sandwich (Hawaiian) Islands in 1778, the naturalist, Nelson, who was in his party, collected specimens of a tree cotton indigenous to the islands, and later deposited them in the British Museum. From the imperfect specimens there, Seeman described[1] the species as *Gossypium drynarioides*.

The plant was long lost to sight; many years later three trees were found by a colonist, but again lost; and when Hillebrand, in 1888, described the flora of the Hawaiian Islands, he was able to cite[2] only five trees of this species. "It is much to be feared," he added, "that this rare and interesting tree is doomed to extinction, as it grows in regions mostly accessible to cattle."

The tree mentioned was known to the natives as kokio (pronounced ko-kee'-o); its close relationship to the commercial cotton plants is indicated by the fact that Seeman placed it in the same genus. Reaching a height of 12 to 25 feet, it produces large, somewhat trumpet-shaped, brick-red flowers, the petals of which are 3 to 4 inches long; and later each flower gives rise to a seed boll, containing several seeds covered with a short, reddish-brown hair.

In itself, it appears to have no economic importance; but since the rise of the science of genetics has given breeders such a keen realization of the value of the wild relatives of important cultivated plants, it was impossible that this wild cotton should escape consideration, as of possible value in hybridization with the low-growing species commonly cultivated. But when the attempt was made to get this tree-cotton, it was found to be almost too late. There was grave doubt as to whether the tree could be saved from absolute extinction. It is the purpose of this paper to describe the measures by which an exceedingly rare plant of great interest has been saved from perishing altogether.

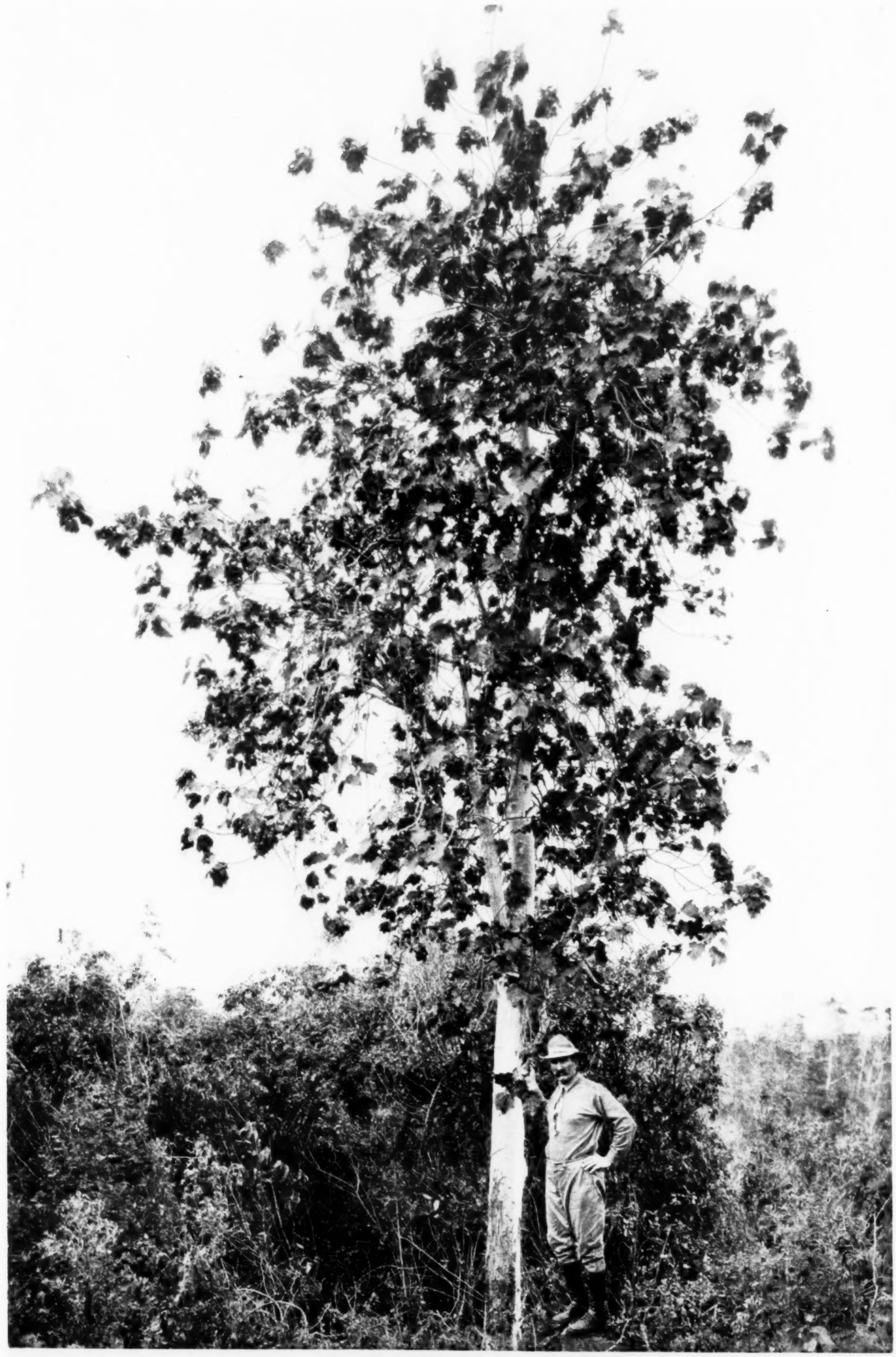
BOTANISTS BECOME INTERESTED

It was in 1911 that this red cotton of Hawaii came to the attention of the Office of Foreign Seed and Plant Introduction of the United States Department of Agriculture, through the receipt of four seed bolls from the Superintendent of Forestry in Honolulu. The data in regard to the kokio, at that time available to men of science, were exceedingly meager, consisting, aside from a few specimens, of very short and incomplete botanical descriptions. As the seed came in as a cotton, it was referred to Frederick L. Lewton, curator of the division of textiles of the United States National Museum, who was greatly interested in the cotton genus. He at once recognized the value of the material and upon his suggestion a request for more was sent back to Honolulu. Shortly afterward a few more seeds were secured through the activity of Joseph F. Rock, the botanist

[1] Seeman in Fl. Vit., 1865, p. 22. He notes that he was undecided for some time as to what genus should receive this tree.

[2] Flora of the Hawaiian Islands, by William Hillebrand, M.D. Heidelberg, 1888, p. 51.

The Journal of Heredity



THE KOKIO TREE OF HAWAII

An almost extinct relative of the cultivated cotton, the seeds of which have been distributed to the Botanic Gardens of the world, in an attempt to save it from extinction. Whether it will cross with the cultivated cottons, and what the hybrid would be, are yet unknown. This tree stands on an old lava bed in the Island of Hawaii, and, through the action of the United States Secretary of Agriculture and the Governor of Hawaii, has been protected from destruction by cattle. (Fig. 6.)

who had collected the seed—who had, in fact, actually discovered the trees from which the seed came.

When it was realized, not only that this wild cotton was scarce but that it might in a few years, or even in a few months, become extinct altogether, the Office of Foreign Seed and Plant Introduction took immediate steps to arouse interest in preserving it. The narrow margin of safety will be realized from an extract of one of Mr. Rock's letters dated March, 1912:

"I have been on the island of Hawaii for two months and have just visited the section in which these most interesting and beautiful trees grow. I am sorry to say that some of the trees I found alive on my last visit have died; but I found another section where there are three more trees in very good condition. I have brought up the question of preserving these trees, but until now hardly anything has been done.

"The lessee of the land of Puuwaawaa, where some of the trees grow, has just applied for some more land where these last-found trees grow, and I have suggested that it be made a condition in the lease that these trees be fenced off in such a way as to protect them from any kind of animal. Each tree will be given an area of half an acre, in order to protect the growth of young trees. The question now is to protect the trees by law from the inhabitants, who strip the trees of their bark, which they use in dyeing their fish-nets; the color of the sap is reddish and it is waterproof."

DANGER FROM CATTLE

Mr. Rock adds that the trees grow on very arid land where vegetation is scarce; cattle therefore strip the trees of all the branches they can reach. The fruiting season is in July or earlier.

"On Molokai," he continues, "the kokio has become a thing of the past, as the last tree which I found on the west end of the island has succumbed to the ravages of sheep, goats, and cattle.

"Many are the trees that should be protected; for example, the newly-described genus, Hibiscadelphus, with two species, of each of which there is only one tree in existence.[3] Cattle are doing great harm to the native trees, and I venture to say that not many years hence these interesting plants will be a thing of the past."

It was thereupon arranged to have all the available kokio seed in Hawaii gathered each year and sent to Washington, and the United States Department of Agriculture wrote the governor of Hawaii on the subject. He promptly took steps to protect the kokio trees, in an effective way.

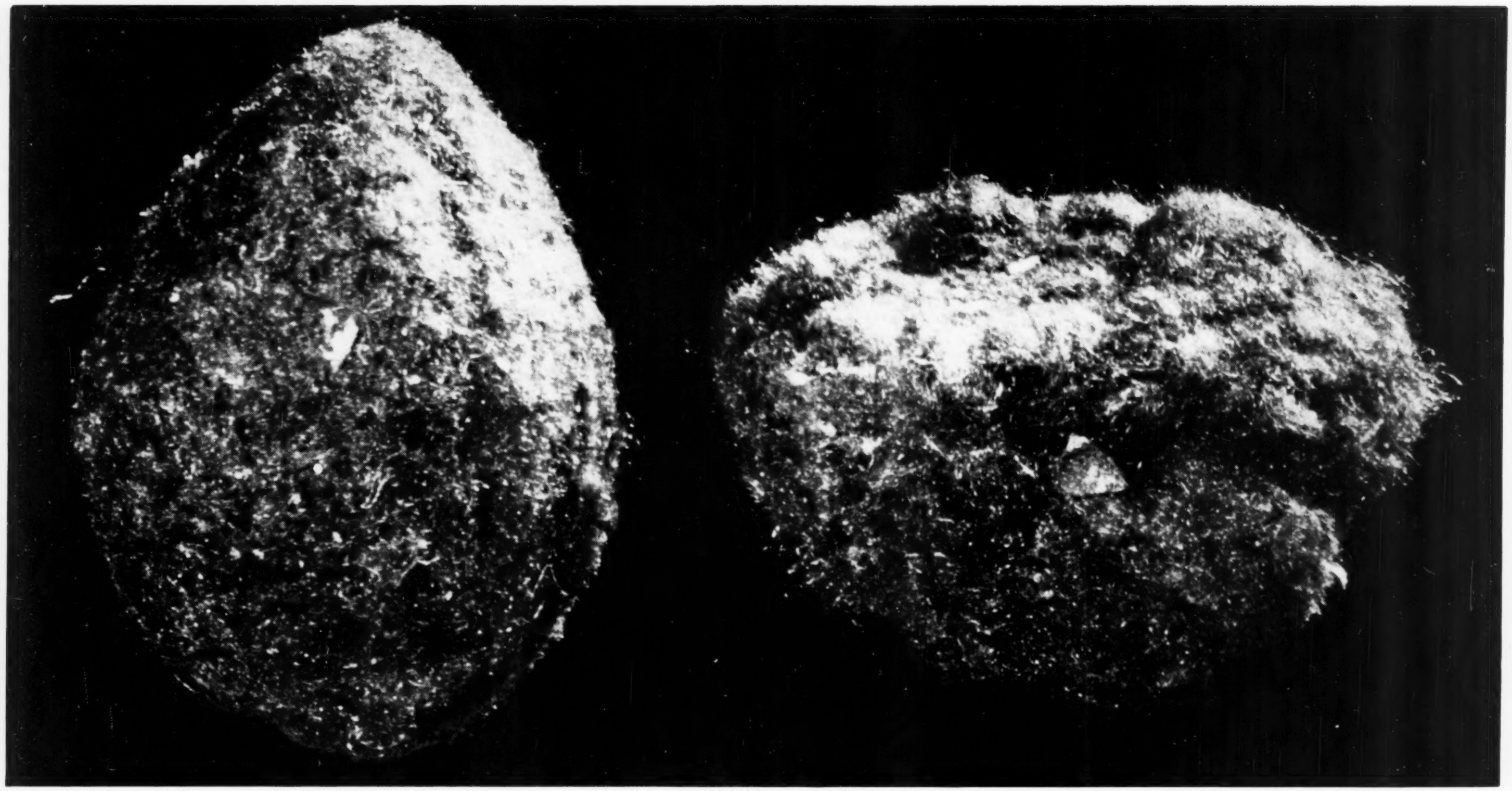
Meantime, Mr. Lewton had been studying botanical specimens which Mr. Rock had collected from the island of Hawaii, and found they were different from those earlier described from the islands of Molokai and Oahu. Further deciding that the kokio was too different from the true cottons to be included in the same genus, he established the new genus, Kokia,[4] for them, retaining the original form as *K. drynarioides* and giving to the form from Hawaii the name *K. rocki*, in honor of its discoverer.

In the next year several pounds of kokio seed were received by the Office of Foreign Seed and Plant Introduction, and distributed to more than sixty botanical institutions throughout the world, mostly in tropical and subtropical countries. In general, attempts to grow the seed met with poor success, but they were established in several different localities. The distribution will be continued for some time, in order that this genus may become as widely dispersed as possible.

---

[3] The loss to science, if any considerable part of the native flora of the Hawaiian Islands is destroyed, may be inferred from the fact that about 80% of the species in the islands are endemic—that is, are found in no other region. Excluding small islands such as St. Helena, this percentage is surpassed only by Western Australia, where it approaches 85. The percentage of endemic species in Central America is 70, in India 60, in Ceylon less than 30. It is obvious that the loss of a species from Hawaii will in four cases out of five mean its loss to the entire world.

[4] Lewton, Frederick L. Kokia. A new genus of Hawaiian trees. Smithsonian Misc. Coll., Vol. 60, part 5, Oct. 22, 1912. Like the native name on which it is founded, this generic name is accented on the middle syllable.



SEEDS OF THE KOKIO TREE

The photograph, very highly enlarged, shows the short covering of red hair on these seeds, which are usually from one-half to three-quarters of an inch in length. The seeds are not known to be used by the natives, but the bark is stripped from the trees and used in dyeing fish nets. This practice has led to the destruction of many of the trees, but is now stopped by government action. (Fig.7.)

While on a visit to the Hawaiian Islands in the summer of 1913 to study the taro industry, the senior author made a trip to the North Kona region on Hawaii where the kokio is found, and through the courtesy of Robert Hind, owner of the Hind Ranch at Puuwaawaa, was enabled to visit the trees nearest the ranch headquarters. The hearty co-operation of Mr. Hind was an important factor in successfully carrying out the plan to protect, by fencing, the larger grove of kokio trees on the leased Government land.

GROWS ON LAVA BED

The little group visited, consisting of four trees, is perhaps a mile from the headquarters, which are at the base of the old volcanic cone, Puuwaawaa, on the slope of Mt. Hualalai. Immediately on leaving the grounds about the house one comes to the lava bed on which the kokio trees grow. This bed, while more or less covered with scrubby growth, has as yet scarcely begun to decompose, and is therefore exceedingly rough and difficult to traverse, even on horseback. The residence on the ranch is at about 2,700 feet elevation, while the kokio trees are a few hundred feet lower. The annual rainfall at the ranch averages 29 inches but is probably much less where the kokio trees grow; besides this, the dry air and the winds which frequently follow the showers, quickly absorb the moisture from the rocky soil. The flora of the lava bed is of a desert type.

The trees do not stand close together; in some cases they are separated by several hundred feet. They are surrounded by the shrubs and weeds common to the lava field in that vicinity. The photograph of the best of the four trees, reproduced on another page, shows the general habit of growth at this place, and the surrounding vegetation. It fails, however, to give any idea of the rough character of the surface of the lava. Much of the shrubbery had to be broken down before the tree could be photographed satisfactorily. The other trees in this group were less regular in form and more spreading in proportion to their height than the one shown. Mr. Hind is standing beside the tree.

As a result of four years of diligent effort, the kokio may safely be considered now to have passed beyond the danger of extinction. It is to be hoped that equally successful efforts will be made to save other wild relatives of cultivated plants, not only from sentimental reasons but because any one of them, even the least promising in appearance, may turn out, in the hands of plant breeders, to be of great value to the world's agriculture.

New Publication on Eugenics

"Eugenical News," a bi-monthly newspaper published by the Eugenics Record Office, Cold Spring Harbor, Long Island, N. Y., has appeared in the first issue of its first volume, under date of January, 1916. It covers four pages, six by nine inches. Primarily intended to disseminate news about the Record Office, it will also include within its scope news of the progress of eugenic research in general, of new laws and institutions which bear on eugenics, and "facts as to differential fecundity, facts as to the control of the death rate of different social classes and of national immigration and emigration."

SEX IN LIVESTOCK BREEDING

Inheritance of Many Characters is Affected by Sex, but this Phase of Heredity Does Not Offer Great Possibilities to the Practical Breeder at the Present Time

E. N. WENTWORTH
Professor of Animal Breeding, Kansas State Agricultural College, Manhattan, Kans.

SOMATICALLY there are four types of inheritance with reference to sex. The first category of character is entirely independent of sex; the second is linked to the sex-determining factor in transmission; the third differs in expression according to sex, although the zygotic constitution is the same; and the fourth is confined to one sex, although it may appear in a rudimentary form in the other. The first two groups develop independently of the secretions of the sex glands, the second two are conditioned in their development by the presence and activity of the testes or ovaries. In the first group fall the great bulk of characters observed in domestic animals; in the second a number of characters observed in insects, birds and man; in the third a few cases in mammals with an instance or two in insects; and in the fourth, the mass of secondary sexual differences found in birds and mammals. Just where the secondary sex characters of insects should be included is at present doubtful.[1]

CHARACTERS INDEPENDENT OF SEX

Evidence on characters totally unrelated to sex is unquestioned, the hundreds of experiments substantiating Mendel's law being cases in point. Some of these discoveries have been of real economic interest, as for example the transmission of the polled character in cattle or the inheritance of coat-color in horses.

SEX-LINKED INHERITANCE

The second group of characters has been of particular interest to investigators, because of the parallelism afforded between the transmission of such characters and the distribution of the so-called X-chromosome in gametogenesis and fertilization. The practical application of this knowledge, however, seems at present limited to the field of poultry, although there are certain facts which point to an ultimate usefulness in the breeding of dairy cattle.

THE BARRED PLYMOUTH ROCK

The knowledge (Spillman, Goodale, Pearl and Surface) that the cock has apparently two doses of the sex-linked characters, while the hen has but one, has proved of value in the breeding of Barred Plymouth Rocks to the show standard. A certain shade of barring is desired in this breed and it has always been a difficult problem to get flocks that would produce both males and females that were standard. When standard males were mated to standard females, the progeny were too light and the females were too dark. Cocks that sired standard females always sired light males, while cocks that sired standard males always had to be mated to dark females for this purpose and moreover produced very dark daughters.

The apparent explanation of this difficulty is that the factors which reduce the degree of pigmentation and produce the white bars are cumulative in effect, and the male that is duplex for the barring factor is lighter than a simplex male or the female. One needs, then, two flocks in order to produce standard fowls. The female producing flock will have light males while the male producing flock will

[1]If the sexual glands of caterpillars are removed at a very early age, the butterflies produced by these caterpillars nevertheless show all the expected secondary sexual characteristics. It appears, then, that these characteristics are wholly independent of the secretions of the reproductive organs.

utilize standard males and dark females. While this is the natural explanation of the facts, and gives the desired results, it would be far better for breeders to recognize that there is a true sex difference, and to make the standard for females proportionately darker than the standard for males.

HIGH EGG LAYING POWER

Pearl (1912) has rendered a great service from an economic standpoint through his discovery that high laying is inherited as a sex-linked factor. By high laying is meant the ability to produce more than thirty eggs during the winter laying period of the pullet year. This is simply a standard which by careful mathematical methods has been shown to be very closely correlated with high laying throughout life. It does not mean that a hen which does this and then stops laying is a high layer, although such a hen is probably potentially a high producer, her failure being due to some extraneous cause.

By selecting the males and females on the old idea of breeding the best to the best (males from two-hundred-egg hens to females laying above 150 eggs), during a period of ten years, there was no significant change in the mean production of the flock. As soon as the system of selection was based on the knowledge that the high laying was due to the inheritance of a sex-linked factor (Pearl, 1915), the average began to rise and in the first year, November, 1913, to July, 1914, the flock produced more eggs per hen than even in an artificial year made up of the best months during the ten years of mass selection.

POSSIBILITIES IN DAIRY CATTLE

Cole mentions the fact that dairy cattle men have believed that the male influences the milk flow of the daughters more than the female does, and quotes one or two authors on the subject. Definite evidence on the point is difficult to obtain, although there have been suggestions at various times that sex-linkage may be involved. In a study of 5,691 Holstein cows with their daughters, two of the writer's former students, Hills and Boland, discovered a correlation of 0.29 between the maternal records and those of the offspring.

If the cow is homozygous for the sex factor, as seems probable, and if the animals studied were perfectly heterogeneous, this might indicate a sex-linkage of certain of the production factors, as a correlation of less than .25 would normally exist. An alternative explanation is possible, however, as the material studied was selected on an advanced registry (high production) basis, and the daughters which failed to attain the standard were not included among the advanced registry individuals. This would tend to raise the correlation coefficient perhaps sufficiently to account for the amount noted.

SEX-LIMITED INHERITANCE

What was designated in the first paragraph as the third type of inheritance has frequently been assumed to be a form of sex-linked inheritance. Arkell and Davenport have devised a scheme which bridges all of the voids between the true sex-linked inheritance and the characters whose expression is affected by the sex gland, but it is doubtful whether such an explanation is necessary since that assumed by Professor Wood, the discoverer of the phenomenon, is both simple and reasonable.

Wood crossed Suffolk sheep, polled in both sexes, with Dorset sheep, horned in both sexes, and obtained horned males and polled females. When such crossbred horned rams and polled ewes were mated, the male offspring showed three horned individuals to one polled, while the female offspring showed one horned individual to three polled. Dominance was reversed in the two sexes, the horned character being dominant in the male and the polled character being dominant in the female.

A few years ago the writer discovered a character in swine which showed a similar mechanism of inheritance. On the lower part of the scrotum of the male, and well to the rear of the inguinal pair of mammæ in the female, there frequently occurs a small rudimentary pair of mammæ. This character has been shown to be dominant in the male and recessive in the female,

as a result of observations on a large number of animals, about 3,000, and also as a result of a few directed crosses.

This last spring, due to the kindness and cooperation of Professor O. E. Reed, of the department of dairy husbandry, Kansas State Agricultural College, facilities were extended the writer whereby another character was discovered which falls within this category. The Ayrshire herd bull, Melrose Good Gift, is a dark mahogany and white in color, what is popularly known as black. The occurrence of black and white Ayrshires was recently discussed in the JOURNAL OF HEREDITY by Kuhlman. It is difficult to determine whether the dark hairs are due to excessive deposition of red pigment within the hair or whether there is really a black pigment. Microscopic examination seems to indicate the latter condition, but the statement is only tentative.

When Melrose Good Gift was mated to red females, his male offspring were all black and his female offspring were all red. Nine black males and eight red females have resulted from this cross to date. Matings representing the F_2 cross are very few, only two being available. One black bull and one black heifer have resulted. The black is the most reasonable expectation in the male, but the chances in the female would be three reds to one black. Two black cows are in the herd and their progeny are as follows: one black male and three black females by the homozygous black bull (the expectation); two black males, two black females, and one red female by heterozygous black bulls (also the expectation); and one black male and one red female by red bulls (the same types as in the first cross mentioned). Other types of crosses exist, all of which supply confirmatory evidence for the conclusions already drawn.

SECONDARY SEX CHARACTERS

The term sex-limited inheritance was first used for the secondary sexual characters, but its usage has varied so that the writer prefers to adopt the terminology herein presented. Information on these characters is classic, Darwin having dealt with them in an exhaustive manner in the materials supporting his theory of sexual selection. Sex differences are familiar to the livestock breeder, the inhibition of their development by unsexing being common, and it is doubtful if there are any practical possibilities involved in this subject that are not already realized by the breeder.

APPLICATION TO PRACTICAL BREEDING

The breeder's problem relating to sex and livestock is the practical one. It can hardly be denied that either form of sex-affected inheritance exists, but the breeder requires more than the mere existence of a fact to make use of it. The study of the individual character has shown that its distribution can be controlled with little difficulty, but no practical means is known of beating the old method of mating the best to the best, when the large number of characters are concerned on which pure-bred selection is based. In the face of Pearl's remarkable work on poultry, it seems ultra-conservative to make this statement, but no one has yet shown how any of the Mendelian knowledge can be applied to the breeding of Poland-China or Hereford. The livestock industry is so much more intimately involved with finances than with ultimate breed improvement that it is not fair to ask any related biological fact to reduce itself to monetary terms. Some facts have been able to be so reduced, but the majority may never be. Yet this condition is by no means a cause for despair, as the solution is perhaps not distant. In the meantime the geneticist will continue to contribute his quota to livestock breeding, whether his contribution be "linked" or "limited," remembering that in the course of the world that which is most fundamental is ultimately the most practical.

LITERATURE CITED

Arkell, T. R., and Davenport, C. B. (1912). "Horns in Sheep as a Typical Sex-Limited Character." Science, N. S., Vol. 35, pp. 375–377.

Cole, L. J. (1913). "Sex-Limited Inheritance." American Breeder's Magazine, Vol. IV, pp. 154–161.

Goodale, H. D. (1909). "Sex and Its Relation to the Barring Factor in Poultry." Science, N. S., Vol. 29, p. 1004.

Hills, F. B., and Boland, E. N. (1912). "Segregation of Fat Factors in Milk Production." Proc. Iowa Academy of Science, Vol. XX, pp. 195–197.

Kuhlman, A. H. (1915). "Black and White Ayrshires." Journal of Heredity, Vol. VI, pp. 314–322.

Pearl, R. (1912). "The Mode of Inheritance of Fecundity in the Domestic Fowl." Journal of Experimental Zoology, Vol. 13, pp. 153–268.

Pearl, R. (1915). "Mendelian Inheritance of Fecundity in Domestic Fowl, and Average Flock Production." American Naturalist, Vol. XLIX, pp. 306–317.

Pearl, R., and Surface, F. M. (1910). "Further Data Regarding the Sex-Limited Inheritance of the Barred Color Pattern in Poultry." Science, N. S., Vol. 32, p. 870.

Spillman, W. J. (1908). "Notes on Heredity: Spurious Allelomorphism." American Naturalist, Vol. 42, pp.

Spillman, W. J. (1909). "Barring in Barred Plymouth Rocks." Poultry, Vol. 5, No. 11, pp. 7-8.

Wentworth, E. N. (1913). "Inheritance of Mammae in Duroc Jersey Swine." American Naturalist, Vol. XLVII, pp. 257–278.

Wood, T. B. (1905). "Note on the Inheritance of Horns and Face Color in Sheep." Journal of Agricultural Science, Vol. 1, pp. 364-365.

Race Hygiene in Germany

The semi-official "Deutsche Zentralstelle für Volkswohlfahrt," corresponding to the United Charities in America, held a three days' meeting in the parliament in Berlin from October 26 to 28, 1915, with about 1,000 delegates attending. The conference was called "Tagung für die Erhaltung und Mehrung der deutschen Volkskraft," with the purpose to find ways and means against the evil consequences of war and modern civilization which menace the vitality of the race. The war kills the best, the bravest, the healthiest, eradicating once for all the finest strains in the race; and city life with all its attendances causes a declining birth rate. The discussion was marked by a unanimity seldom seen in such a large audience. The dominating undertone was race hygiene. Whereas eugenics in America has a restrictive tendency, seeking to check the propagation of the unfit, race hygiene in Germany always was a positive conception aiming at the multiplication of the fit. Thus the conference laid much stress upon everything which may elevate the birth rate of the best in the nation, but thought the introduction of sterilization of defectives or of marriage certificates untimely as yet. Simplicity in customs and mode of life, a full understanding of individual duty towards society, a high valuation of family life, inner colonization ("back to the farm" movement), the system of one-family houses, garden cities, and chiefly the assistance of large healthy families in every way; these were the main remedies proposed, the details of which were fully discussed but cannot be enumerated in a short review. A standing committee representing all societies concerned is now in formation with the view to see the propositions worked out in practice.

G. von Hoffmann, Berlin.

An Important Character in Grains

Certain varieties of wheats, oats and barleys are characterized by fragile articulations, so that the ripe grains easily fall from the head, thus causing a considerable loss of grain before threshing. In crosses, such a defect not infrequently manifests itself, and it would be of great advantage to the breeder to know how to avoid it. G. von Ubisch has been investigating this character in barley and states his conclusion in the *Zeitschrift für induktive Abstammungs-und Vererbungslehre*, July, 1915, that it depends on two Mendelian factors, both of which must be present to produce this effect. If his conclusions are sustained, they will be of great value to breeders of cereals.

Cross and Self-Fertilization

Working with cotton, the Arkansas Agricultural Experiment Station is testing the effects of cross and self-fertilization, in four different degrees, comparison being made of the results when blossoms are self-fertilized, when they are pollinated from other blossoms on the same plant, when pollinated from another plant of the same variety, and when pollinated from a plant of a different variety. Since Darwin's classic experiments, very little notable work has been done in this field, but the claim of the harmlessness of self-fertilization, put forward largely on theoretical grounds by various recent students, renders it necessary that the question should be again taken up and new evidence procured. The Arkansas station hopes to be able, by this series of experiments, to get absolute measurements of the results produced by the various degrees of close-breeding. While the question is one of great theoretical interest, particularly for the bearing it has on the evolution of sex, it has also a practical importance; for if it were generally admitted that self-fertilization is injurious, breeders would change their methods in many cases.

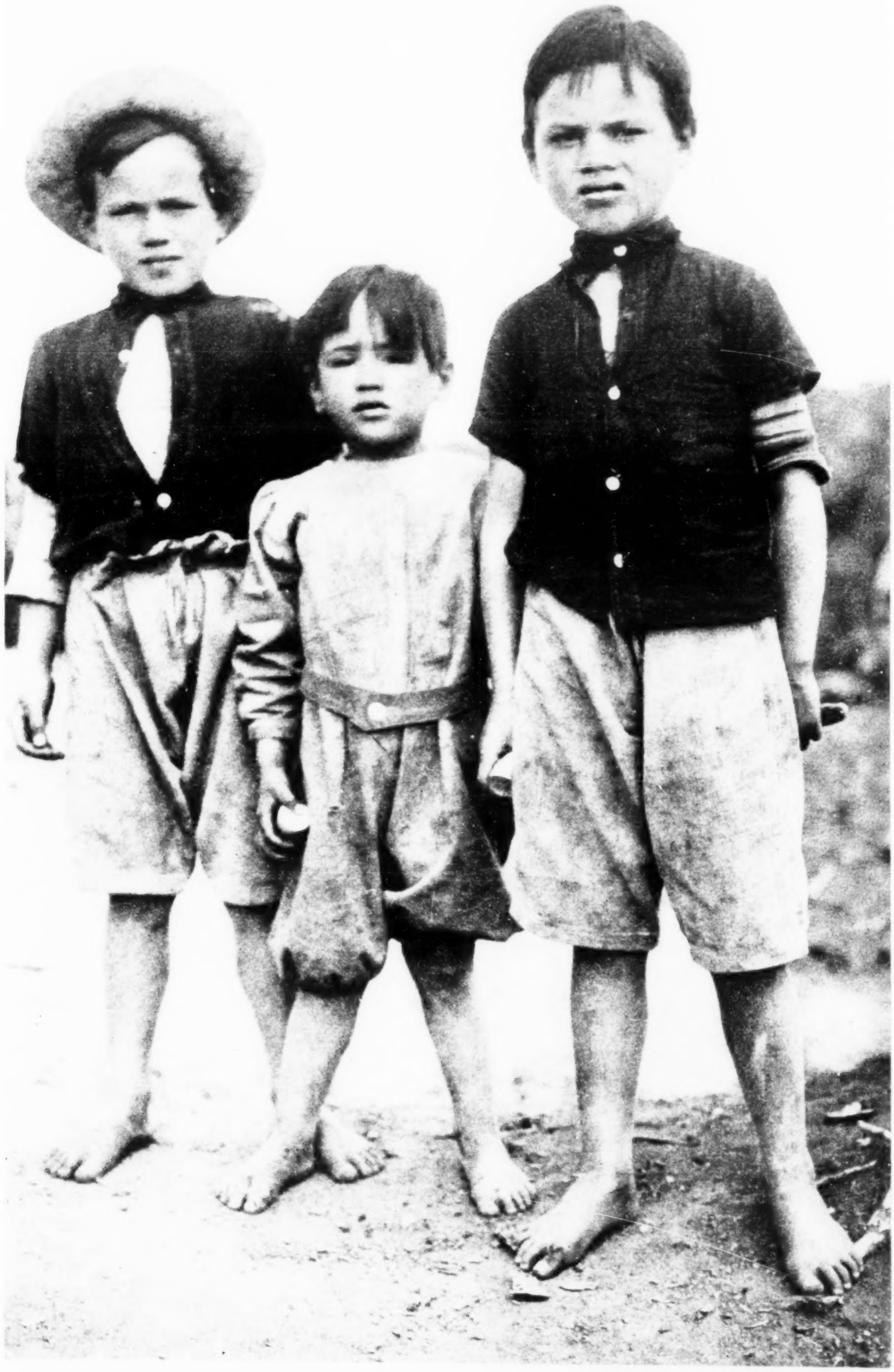
The question of cross- vs. self-fertilization and its effect on vigor should not be confused with the question of hybrid vigor, for there is little doubt that most first-generation hybrids show marked vigor—to such an extent that corn, tomatoes and many other crops are best grown from first-generation hybrid seed. The distinction which the Arkansas and other stations are developing, is rather along the line suggested by A. D. Shamel's statement, in the second annual report of the American Breeders' Association, that "Self-fertilized tobacco seed, the result of the closest possible degree of inbreeding, has been conclusively demonstrated by four seasons' experience and experiments in extensive fields of different varieties of tobacco to produce more vigorous plants than seed cross-fertilized within the variety. Crosses of different strains of tobacco, however, give increased vigor of growth, leaf and seed production."

It should be noted that Darwin's own experiments did not show self-fertilization to be detrimental in every instance. Notably in the case of the California poppy (*Eschscholtzia californica*), self-fertilized seeds produced plants which surpassed the plants from cross-fertilized seed, in three out of four cases. So it is possible that conditions may vary with different plants, although one is naturally inclined to suppose that a principle of such fundamental importance in the struggle for existence ought to hold good throughout nature.

But even before this problem is finally settled, there are some lines in which breeders can work with great possibilities of commercial profit, and the Hawaiian experiment station has started one of these, by attempting to breed a strain of papayas (*Carica papaya*) with self-fertile flowers. The papaya, one of the important fruits of the tropics, is irregularly monoecious; obviously, if male trees could be altogether eliminated, a considerable saving would occur in planting. Since trees with perfect flowers are occasionally found, the station is endeavoring to make this type supplant the ordinary monoecious type altogether. The experiment is now in the second generation, in which more than 400 trees were raised; 96% of them were self-fertile, the few remaining trees not being exclusively male in character but showing a strong tendency to bear fruit. As in nature the males make up about half of the trees, the economy of space should be large when the new strain is perfected.

IGORROT X AMERICAN METIS

The effect of racial crosses can be studied to good advantage in the Philippines, where intermarriages of many different racial stocks have taken place during the last few generations. The above photograph shows an Igorrot woman with her four children by a white American husband. The Igorrots, one of the principal tribes of the islands, are



of Malayan origin. The student of heredity will be interested to note to what extent the characters of the mother dominate over those of the father, in the children. These photographs were taken at Atok in the province of Benguet on the first of January, 1915. (Figs. 8 and 9.)

DAVID B. MACKIE, *Manila, P. I.*

OSTEOPSATHYROSIS

Extraordinary Fragility of Bones Occasionally Found in Babies is Due to Heredity and Behaves as a Dominant Trait in Transmission—Usually Found Associated with a Porcelain Blue Color of the "Whites of the Eyes."

A Review

ON July 11, 1893, a boy was born under normal circumstances who, when examined by the attending physician, was found to have appeared in the world with both thigh bones broken. The legs were put in splints and union of the bones occurred in three weeks.

On September 11 he broke an arm and a leg, but they again united nicely.

On March 1, 1894, the boy, sitting in a chair, fell forward but not out of the chair and suffered a fracture of the right femur near the hip.

On September 11 his left thigh bone was broken again; a union occurred, but in October the bone was fractured once more.

In the spring of 1895 he fell out of his hammock and broke both thigh bones; three months later the right one was again fractured.

It is thought that he suffered fractures at other times, that were less carefully noted. At any rate, by the time he was 2 years and 10 months old a careful examination revealed certainly twelve fractures and possibly seventeen or eighteen; but already they had begun to occur less frequently.

The following points about the case are worthy of notice:

(1) In early infancy there was an extraordinary liability to fracture;

(2) but it began to diminish as the baby grew older;

(3) the fractures occurred from trivial knocks and, apparently, even from merely internal muscular stresses;

(4) healing took place rapidly and left little irregularity in the bone at the point of union. The bone was perfectly healthy and rigid, but the development of a strong structure was much delayed. The bone was not diseased or soft, but was merely fragile.

Cases of this kind are not rare in medical literature, where the affection is known as *osteopsathyrosis*. The cause has been shown by a number of investigators to be an imperfection of the developmental processes involved in the formation of bone. In the ordinary course of development the whole bone is finally enwrapped in a casing of extremely tenacious and flexible bony rods; but in this condition such rods are not formed. There are other abnormalities of the mechanical structure.[1]

One case is on record of a pair of twins, one of whom showed at birth this defective condition of the bones, while the other did not. Inevitably, therefore, we must suspect that the abnormality is not due to anything in the condition of the mother, for in that case both the children should have been affected.

Nor can it be due to anything in later life, for we find that the child's bones are sometimes broken at birth, as in the case cited, or even before.

EVIDENCE POINTS TO HEREDITY

When we find, moreover, that the appearance of this condition is not haphazard, but that it runs in families, we are driven to the conclusion that it is not a result of any environmental conditions. It is a matter of heredity. Either, we may suppose, the child lacks certain hereditary factors that normally perfect the structure of the bone, or perhaps it has received some additional

[1] Such a condition is easily confused with the disease of children known as rickets, and it is possible that some of the cases which figure in the present study are really rickets. The difference between the two is that in rickets there are usually other widespread abnormalities of the skeleton, while in the defect here considered the skeleton is perfect save for the unusual brittleness.

factors that inhibit the action of the normal ones.

As students of heredity, therefore, Professor H. S. Conard, of Grinnell College, and Dr. Charles B. Davenport, of the Carnegie Institution, have reviewed the literature on the subject, added some new cases, and published their conclusions in a bulletin[2] of the Eugenics Record Office. They accept the finding of Schwarz and Bass (1912) that heredity is the only important etiological factor in bringing about this condition, and are able to quote thirty-five family histories in support of it. As an example we notice the chart of four generations of a family found by Professor Conard:

In the first generation are two affected brothers, one of whom had a thigh broken merely from the muscular strain on a turn while dancing. The other brother has a record of a broken thigh and dislocated hip.

From the latter are eight children, half of whom showed the father's abnormality.

In the third generation the number of affected persons becomes still greater, although none of the second generation children had married mates with similar taints.

One of the girls of the third generation, however, married a man who, though not himself affected, had affected cousins. From this union there are five children of the fourth generation, every one of whom shows the abnormality.

From this and other cases the authors reach the conclusion "that the factor which determines the imperfect, brittle development of long bones is a dominant one. This conclusion is based on the fact that, as Griffith (1897) pointed out, the inheritance is generally direct, *i. e.*, does not skip a generation, but appears in one parent and in that parent's parent. Since the trouble frequently shows itself only in early childhood there are, of course, the expected number of cases where a similar condition is not known in either parent, one or both of whom are perhaps dead. But even in such cases the trait is frequently recorded for a brother or sister just because they are contemporaries. Beyond a certain point in the pedigrees, in any case, information must be lacking. What is to be expected on the hypothesis, and what is found, is that affected children rarely if ever arise from an unaffected parent and an affected grandparent."

CONSEQUENCES FOR EUGENICS

"The consequences of this study for eugenics are these: A parent who is, or was in early life, osteopsathyrotic, will have half of his children similarly affected no matter whom he marries; except that if the consort also be osteopsathyrotic it is to be expected that three-fourths of the children will be affected. But if neither parent has shown osteopsathyrotic tendencies then, no matter how frequent the tendency may be among their relatives, expectation is that none of the children will have brittle bones. Moreover, where a parent is affected it is probable that his children will show the same tendency at about the same time in life, in the same bones, and to the same degree as he himself has shown it. As to how far that expectation should influence the reproduction of children the affected parent can best judge from his own experiences."

It will, of course, be understood that the proportions mentioned by the authors are merely averages, reached when large numbers are measured but not likely to be found exact in individual families. Their own study embraces a total of 150 persons, of whom eighty-three were affected. Thus they found 55.3%, whereas expectation from larger numbers would have been, as they say, only 50%.

The classification is admittedly rough, and it seems likely that under the name of osteopsathyrosis physicans have lumped a number of distinct but allied conditions that a geneticist would have separated. Or as the authors

[2] Hereditary Fragility of Bone (fragilitas osseus, osteopsathyrosis), by H. S. Conard and C. B. Davenport. Eugenics Record Office Bulletin No. 14, Cold Spring Harbor, Long Island, N. Y. November, 1915. Pp. 31, price 15 cents.

put it, the "classical symptoms" probably constitute a complex character whose elements are separately heritable. Much more extended and minute research will be necessary before the problems involved in the inheritance of fragility of bone are settled, but one fact, at least, seems established: that it is heritable, and in the general manner of a dominant trait.

One other fact is worthy of note: this bone abnormality seems usually if not always to be associated with a blue color in the "whites of the eyes." It has been noticed ever since 1840 in medical literature that there are families in which the blue color characteristic of the eyes of infants seems to persist through adult life, and in 1900 Eddowes pointed out that this condition and fragility of bone were correlated. This abnormality of the eyes appears to be heritable and dominant, but as to why it should be associated with brittleness of bone we have no information at present.

Studying Fruits in Illinois

Many seedling apples are being grown at the Illinois Experiment Station. Reciprocal hybridizations between standard orchard varieties and various species of the genus Malus have been made, fifty-seven species and varieties which are not of commercial importance having been obtained from the Arnold Arboretum at Boston. Direct improvement through these violent crosses is not anticipated, but it is hoped to acquire valuable information regarding the affinities of the various species used, and also to produce material for use in back crossing. Reciprocal crosses between standard orchard varieties are also being made in large numbers, while a difficult piece of work has been attempted in the reciprocal crossing of different strains of the same variety, and different individuals of the same strain. C. S. Crandall writes: "This project has aimed at the selfing of particular individuals, and the use on trees growing here of pollen from trees of the same variety in orchards 100 miles away and grown under quite different conditions. Considerable effort has been expended in the prosecution of this project, but up to the present time we have recorded no successful pollinations. We have not as yet a very wide range of varieties, but as far as we have gone we have encountered complete sterility both in the selfing within the individuals and in the attempt to use pollen of the same variety brought from a distance. The unfortunate feature about all the hybridizing work with apples is the mongrel character of the plants on which we work. We know nothing of the parentage of any of our varieties and it seems quite useless to speculate on what the segregation of characters may be in crosses between different varieties. A further discouraging feature in apple breeding is the long period required to get results from any particular cross. Effort is being made to shorten this period by grafting scions of hybrid seedlings on dwarf stocks and growing the plants in pots. This will help some, but at best the attainment of results is some distance in the future. We are endeavoring to maintain a reasonably complete record of every step that is taken so that a complete history may be available for those who may later continue the work.

"In pursuing the projects as outlined above there are a number of minor problems that are receiving some attention: such as the retention of the vitality of pollen, the period of receptivity, the seed production in hybrid fruits, and the time for and percentage of the germination of seeds. On all of these points we are accumulating considerable information that it is hoped may be of some practical value."

ANCESTRY OF THE GOOSE

Ordinary Domestic Breeds Are Descendants, with Slight Modifications, of the Gray Lag Goose, Still Found Wild in Most Parts of the Old World— Breeding in Captivity Must Have Begun at Early Date— Importance in Antiquity

NATURALISTS are agreed that the ordinary breeds of domesticated geese are descendants of the gray lag goose (*Anser anser*, L.) which is still found wild throughout northern Asia, although nearly extinct in Europe.

As it is easily tamed, it was probably brought into captivity at a very early day. E. Hahn suggests that it was the first bird domesticated by man, and as far as Europe is concerned he is doubtless right.

More ancient than their congeners the ducks and swans, the geese stand about half-way between them, in most points of form. The ancestry of these three groups, which make up the Anseres, is not difficult to trace, for the key is furnished by two strange, aberrant forms of goose in South America—Palamedea and Chauna, commonly known as the "Screamers." If, says W. P. Pycraft,[1] the Anseres are not descendants of the archaic Screamers, they at least come from the stock from which these arose. "That is to say, the Screamers may either be regarded as the living representatives of the actual ancestors of the Anseres, more or less modified by time, or as an offshoot of these ancestors retaining most of the original characters thereof."

When man first entered Europe, the gray lag must have existed in immense numbers. Its range is from Iceland to Kamchatka, north occasionally as far as the arctic circle and south to the Mediterranean. It winters principally in India and the adjoining countries.

Pairing for life,[2] the geese build a nest which is little better than a pile of rubbish, and in it the female lays from four to twelve, sometimes fourteen, eggs, resembling in appearance those of the domestic breeds, which she incubates for twenty-eight days. The gander stands guard, seldom moving far from the nest, but the old story that he takes his turn at incubation seems to be unfounded.

The goslings, which on emerging from the shell are covered by a short, thick down, usually take their first bath not later than one day after birth. Alphéraky[3] describes their early training as follows:

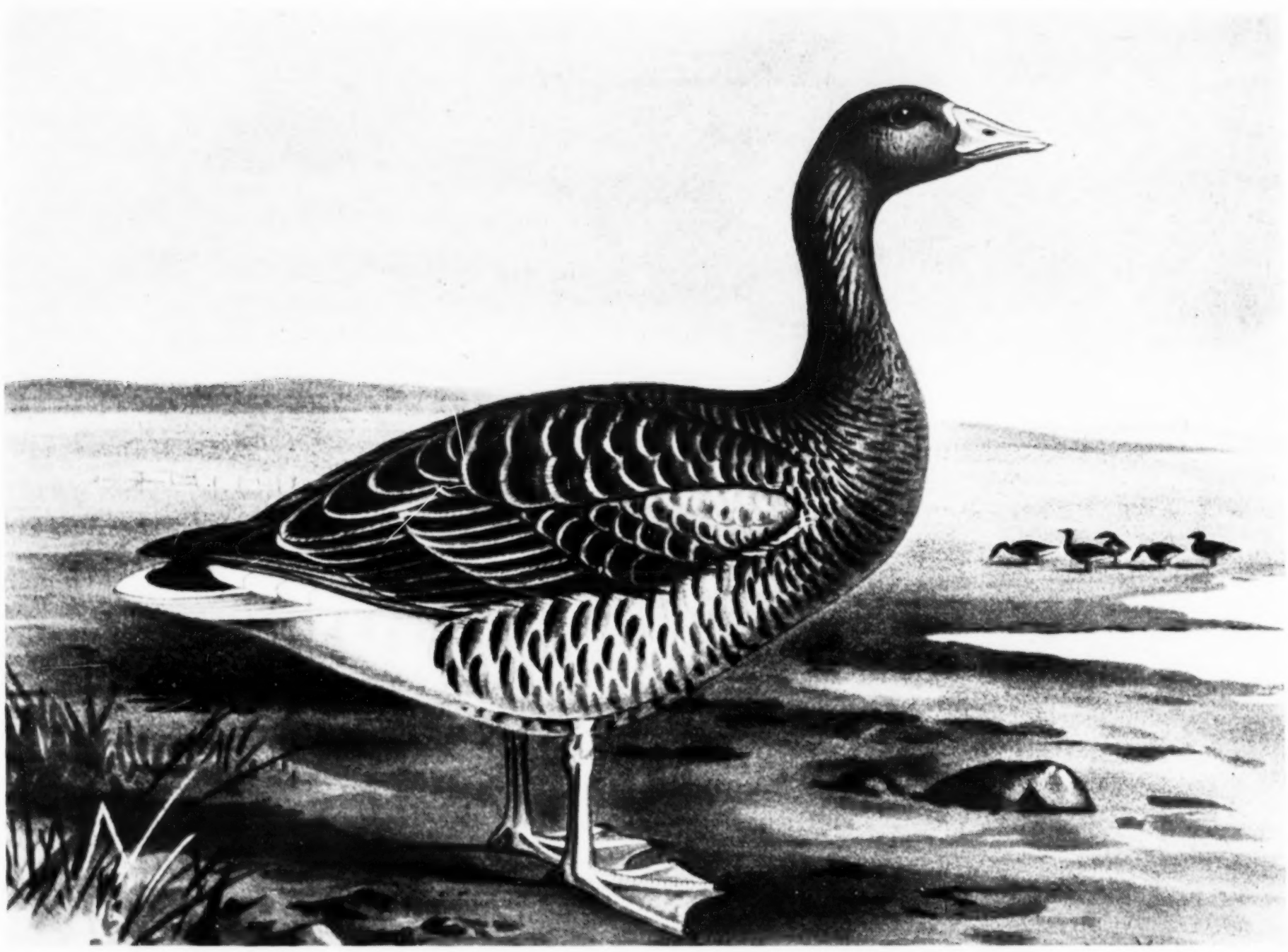
LIFE OF THE GOSLING

"At first the young birds nip off the tender tops of various waterweeds projecting above the surface, but the mother soon tries to lead them away to a green bank or an island, where they begin to graze in the fashion they will follow for the rest of their lives. Towards nightfall the brood returns to the nest, where the young are kept warm under the wings of the mother. Such is the daily life of the young brood until the goslings have grown so large that they cannot find room beneath their mother's wings; but even after this they still pass several nights huddled close to her body. The brood usually goes to feed in the following order: in front the goose, and in her wake the goslings, crowded closely together; somewhat to the rear stalks the gander, with neck outstretched, constantly turning to one side or the other, and keeping a sharp lookout for

[1] History of Birds, London, 1910.

[2] Geese have always been noted for longevity. Alphéraky mentions one in France which, at the age of 35, was still producing a brood each year.

[3] Sergius Alphéraky, The Geese of Europe and Asia. London, 1905.



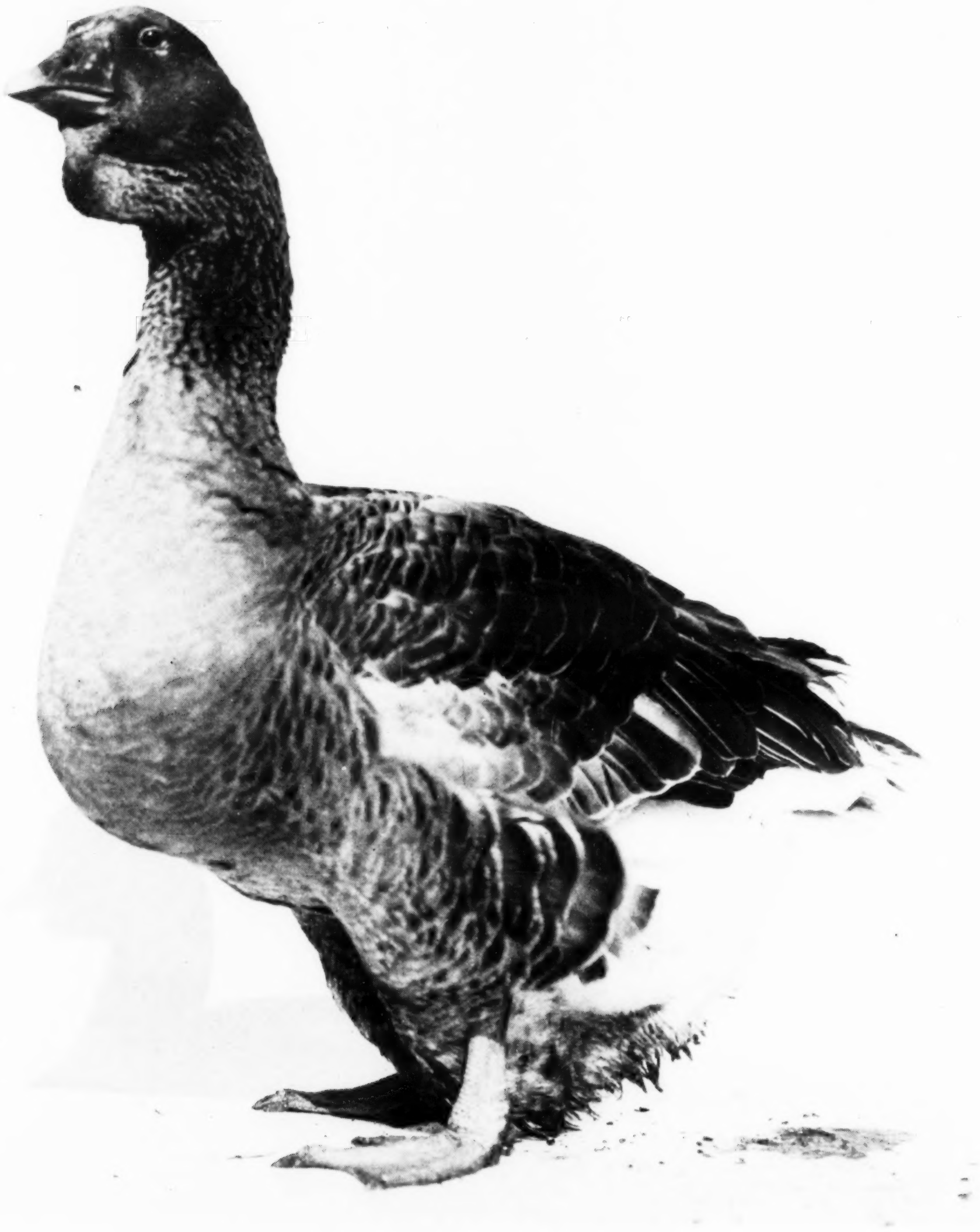
ANCESTOR OF THE DOMESTICATED GEESE

The gray lag goose, here illustrated, was found all over Europe and northern Asia, not many years ago, in countless numbers. Now it is almost extinct in Europe, being easily caught at the time of its moult. It was probably the first bird domesticated in Europe, because of the ease with which it is tamed, as well as because of its value. After Alphéraky. (Fig. 10.)

any threatening danger or conspicuous object. Notwithstanding this watchfulness, in case of actual danger the gander is the first to take wing with a loud cackle, or rather cry, full of fear, leaving the care of saving his children to the female, which, it must be owned, fulfils her duty with complete self-sacrifice. Her first care in the presence of danger is indeed to hide her young brood wherever possible in the grass or undergrowth, and if there be water at hand the brood will sometimes rush in headlong and seek safety in diving.

"If a gosling be caught and removed from the brood, it is said that the mother will fly at the robber and pursue him for a considerable distance. Both goslings and old birds, when they wish to hide, will lie down flat on the ground, with neck stretched out to its full length; this being the habit of large but not yet fully fledged young birds and moulting old ones; although it is not peculiar to the grey-lag, but common to all geese. In case of the death of the parents, the goslings usually join other broods, and are willingly received by the parents of the latter.

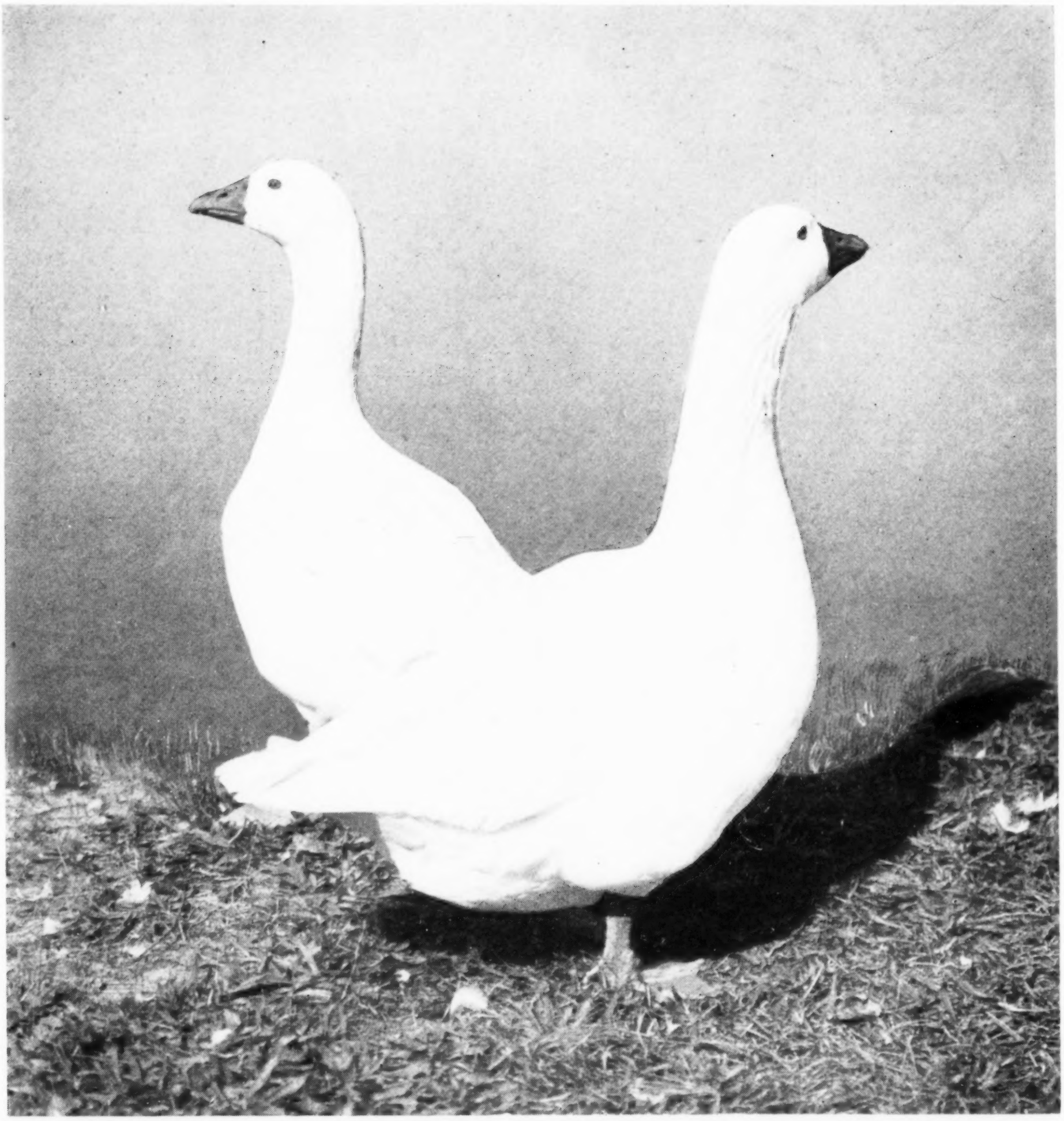
"Naumann relates a somewhat strange trait in the life of the grey-lag, namely, that sometimes the geese will fly off with their offspring from a large sheet of water to a small one, and back again, without visible cause, but with extraordinary persistence and obstinacy. When they have decided to abandon any particular water, they carry out their intention at any cost, even if all the goslings should perish in doing so. The feeble young in down, when hardly two weeks old, are transferred by their parents to other waters lying within a two or three hours' march across the



THE TOULOUSE GOOSE

This popular old French breed shows, except in shape, relatively slight differences from its ancestor, the wild lag. It has become considerably less graceful, due to the demand of its growers for as much meat as possible; on the average, it weighs probably twice as much as the wild form. The small amount of change in the color pattern is particularly noticeable. Photograph of a male, from the United States Department of Agriculture. (Fig. 11.)

open fields or along country roads, past mills, and even through settlements, so that, in such apparently aimless wanderings, the young often perish from the assaults of rapacious foes, or simply from the hardships of the journey. Even if the goslings are caught and reinstated several times on the waters whence the parents had taken them, the latter do not abandon their



PAIR OF EMBDEN GEESE

Breeders in northern Germany, particularly in Westphalia, are responsible for the production of this breed, which is rather more graceful than any other descendant of the gray lag. The creators of the Embden took advantage of the fact that the gray stock frequently gives rise to white sports, and by breeding from these sports produced a variety that rarely shows a return to the ancestral color. White geese were known as a distinct breed even in the Roman times. Photograph from the United States Department of Agriculture. (Fig. 12.)

senseless conduct, but again obstinately carry off their offspring. An attempt has been made to explain such persistency on their part by the instinct of the geese to abandon waters which, according to a presentiment, will dry up in the course of the year; but it is more probable, I think, that the tendency to wander in these birds is caused by the desire to find safer and less accessible spots for the moulting of the old birds.

ADULT LIFE

"When the goslings are fairly grown up and almost fully fledged, the old birds moult—the ganders somewhat the earlier, and after them the geese—and having simultaneously lost all their

primary and secondary wing-feathers, they become, like the ducks, perfectly helpless. Knowing this, they duly retire to still safer strongholds, where they pass this dangerous but not very prolonged period of their life.

"When the young geese have grown their flight-feathers and the old birds are fully fledged, they begin to fly out to the fields to feed, sometimes in separate broods, at other times in parties; and it sometimes happens that their feeding grounds are far removed from their places of refuge. . . . We owe to Vavilov the following lifelike description of these foraging expeditions: 'A little later the separate broods combine to form flocks; and from this moment the geese no longer fall such an easy prey to the fowler. Such gaggles feed in the corn-fields, especially buchwheat, peas and oats. Having once selected a field, they constantly fly to it, even continuing to visit it after the harvest to glean the scattered grain. At this period the geese live a life of ease and luxury. With sundown they fly to the field, crowding the crops to an incredible extent, and at the call of the old birds rising heavily and making for the lonely lake to pass the night. They always fly by the same route, and as soon as they reach water at once descend and devote their first attention to slaking their thirst, and then swim to the selected open shore, where they get out, lie down, and fall asleep. The old birds alone do not sleep, but divide the watches, and, if they hear anything suspicious, at once wake the whole flock with a loud cry of warning, and in an instant fly up into the air. . . . After a doze of an hour or two, long before dawn the geese on guard wake their sleeping companions, and again the whole flock flies off to the favorite field, where it remains until early morning. Having taken their fill, the geese now fly to another lake, where they pass the day. In the evening they again fly to the field, and so on until their departure.' "

In winter the goose is languid and inactive, passing whole days in dense growths of reeds, surrounded by quagmires, and inaccessible alike for man and beast.

Wild specimens weigh from 6 to 12 pounds; specimens as large as 16½ pounds have been reported, however. The individual variation in the coloring of the plumage and of the naked parts of the bird is subject to innumerable changes, as with all species of geese.

EARLY DOMESTICATION

The very abundance of the bird in a wild state must have tended to delay the time of domestication, for, as Hehn points out, "Where it was abundant and easy to obtain, there was no necessity for breeding it artificially in confinement; and so long as men's manner of life was unsettled, a bird that takes thirty days to hatch, and a proportionate length of time to rear its young, was unsuitable to the economy of a pastoral people."

This explains, perhaps, why we find its remains lacking in the Swiss lake dwellings, whose period is probably 2000–4000 B. C. When we come to the classical period, however, we find it well established.

"By the Greeks the goose was considered a graceful bird, admired for its beauty, and an elegant present for favored friends. In the Odyssey, Penelope has a little flock of twenty geese, in which she takes much pleasure, as we learn from the beautiful passage in which she relates her dream to her disguised husband. Here the geese appear as domestic animals, kept more for the pleasure the sight of them affords than for any profit they might bring. So, in the Edda, Gudrun keeps geese, which scream when their mistress laments over the corpse of Sigurd. At the same time, the Greeks valued geese as careful guardians of the house; on the grave of a good housewife was placed the figure of a goose as a tender tribute to her quality of—vigilance!

"Among the Romans perfectly white geese[4] were carefully selected and used

[4] There appears to be in the lag goose and its descendants a strong tendency to the production of white mutants. The same seems to be true of the Chinese species, judging from the fact that a white variety of the breed has been created.

MALE AFRICAN GOOSE

The name of this breed is a misnomer, for it is really founded on the Chinese goose, a distinct species which has the honor of being the largest of all wild geese. The Chinese species interbreeds freely with others, and the breed known as African contains varying proportions of gray-lag ancestry. The plumage of the bird here shown indicates that the Toulouse goose may be not a remote ancestor; the peculiar fleshy protuberance at the top of the beak is a characteristic of domesticated forms of the Chinese species, although it does not appear in the wild birds. The black stripe down the back of the neck is characteristic of the species. Photograph from United States Department of Agriculture. (Fig. 13.)

for breeding, so that in course of time a white and tamer species was produced, which differed considerably from the gray wild goose and its direct descendants. In ancient as in modern Italy, the goose was not so commonly found on small farms as in the North, partly because the necessary water was scarce, and partly because of the damage she caused to young vegetation. But numerous flocks of this bird cackled in the huge goose-pens (*chenobosca*) of breeders and proprietors of villas; there the enormous liver that made the mouth of the gourmand water was produced by forced fattening—an artificial disease which was poor thanks for their saving the Capitol. The use of goose feathers for stuffing beds or cushions was foreign to early antiquity; the later Romans first learned the practice from the Celts and Germans. In Pliny's time whole flocks of geese were driven from Belgium to Italy, particularly from the land of the Morini, who inhabited the Belgian coasts; the delicate white feathers which came from that country were celebrated. . . . Pillows stuffed with goose feathers were an innovation at which true Romans shook their heads: We have now arrived at such a pitch of effeminacy, adds Pliny, that even men cannot lie down to rest without such an apparatus. Even to the present day, feather-beds are more characteristic of the North, being unsuitable to the warm South. The ancients were also unacquainted with another use of the goose-feather, that of an instrument for writing. The first quill-pens were used at the commencement of the Middle Ages, in the time of the Ostrogoth Theodoric."[5]

CHANGES IN CAPTIVITY

The anatomical differences between the wild species and the modern domesticated breeds are not great. The walk has become a little more of a waddle, the ability to fly is lessened, the rump is deeper. The color pattern of the most widely known breed, the Toulouse, is very similar to that of the gray lag, but simpler. In general, the changes are those which would naturally be produced by selection of specimens which possessed the best marketable form.

The American Standard of Perfection recognizes the following breeds of geese: Toulouse (gray), Embden (white), African (gray), Chinese (both brown and white varieties), Wild or Canadian (gray) and Egyptian (colored).

Of these, the Toulouse seems to have been produced in France, which has long been celebrated for its geese, and the *paté de foie gras* produced from their livers. It owes its name to the city of Toulouse.

North German breeders, particularly in and around Westphalia, produced the Embden breed, by selecting white "sports" and breeding from them.

The African breed is of somewhat uncertain history. Though little different in appearance from the gray lag, it is said to be a hybrid between the Chinese goose, the Toulouse breed, and sometimes the Embden. The three preceding breeds comprise the heavyweight or market varieties, weighing from 17 to 25 pounds when properly fattened.

The Egyptian breed comes from an entirely different species (*Chenalopex aegyptiacus*), which has been of much importance to the domestic economy of that country ever since the beginning of history. It is gay in color as compared with the sober descendants of the gray lag.

The Wild or Canadian goose is the domesticated Brant (*Branta canadensis*) well-known to most North Americans. It is easily tamed, but has little commercial importance as a domesticated breed.

The Chinese goose is still another species (*Cygnopsis cygnoides*), an ornamental fowl which lays well and furnishes a good quality of meat. It weighs from 10 to 14 pounds, and is therefore the largest of all wild geese. Although not so well known in the United States as the European breeds, it is yearly becoming more popular and deserves to be widely kept.

All these species can be interbred freely in captivity.

[5] The two preceding paragraphs are from Victor Hehn, The Wanderings of Plants and Animals from their first Home; ed. by J. S. Stallybrass, London, 1888.

A LOST OPPORTUNITY IN BEE-BREEDING

MOUTH PARTS OF THE HONEY-BEE

The outermost pair of organs are the maxillæ; the three in the center make up the labium. The long, central organ is the tongue, covered with long hairs, and terminating in a small, spoon-shaped lobe. The tongue is not a solid appendage, nor yet is it truly tubular, having an opening on its lower side; its cross-section is much like that of the casing of an automobile tire. Liquids rise in the tongue by capillarity and sucking; but when the bee is drinking rapidly from a considerable quantity of nectar, he brings close together all the five organs here shown, and they form a loose tube up which he can suck the fluid. This photo-micrograph by Dr. K. Brunnich represents the proboscis of a worker, the drone and queen having mouth-parts of much smaller size. Reproduced from Gleanings in Bee Culture. (Fig. 14.)

The following answer was given to an inquiry about breeding bees for greater length of tongue, so that they could pasture on red clover, which is ordinarily visited only by bumble-bees:

"Some ten years ago we discovered that we had one colony of bees that would work on red clover when it was in full bloom when all the other bees apparently were doing nothing. An investigation showed that the tongues of bees of this particular colony were considerably longer than the tongues of ordinarily normal bees. The tongue reach of the ordinary bee is between 16/100 and 17/100 of an inch long, while the tongue reach of these red clover bees we found to be 23/100 and 24/100 of an inch. Not much wonder then, that these bees were able to gather honey from red clover, which has very deep corolla tubes, when the other bees could not reach the nectar. We entered into some correspondence with the experiment station, suggesting that if they could shorten the length of the corolla tubes of red clover by careful selection we would make an effort on the other hand to increase the tongue length of our ordinary hive bees. But the effort on our part did not succeed for the simple reason that bees find their mates in the air and we could not control the male parentage. The result was that this particular sport of bees degenerated back to the original normal stock. This is as far as we have ever been able to go, and it was merely an accident that we secured bees of this tongue reach."

E. R. Root, Medina, Ohio.

Food Plants of American Indians

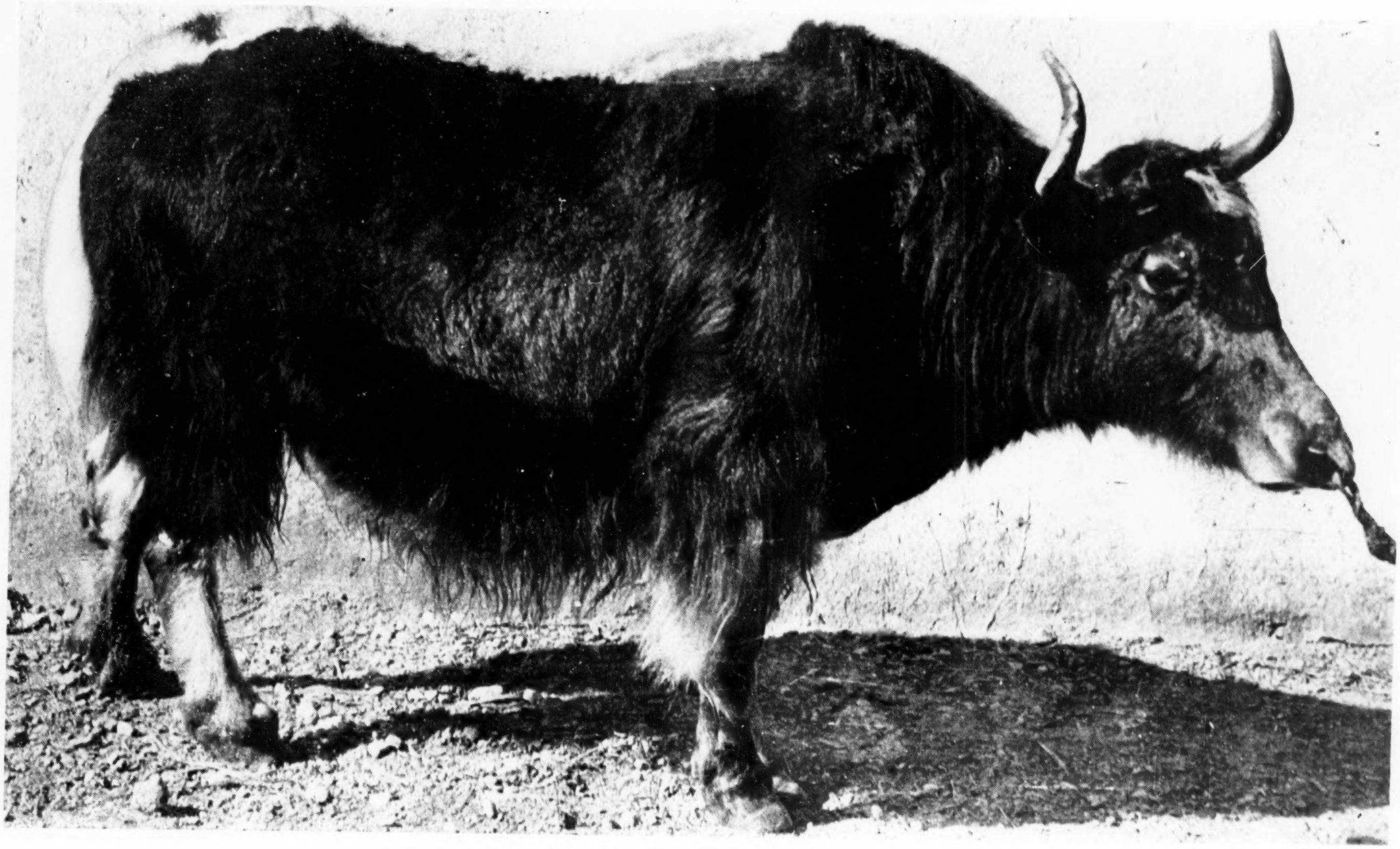
A new and interesting development of American horticulture is the study of crops grown by the American Indians. They have yielded some races of great value, among which one of the best known is the Tepary bean, exploited by the Arizona Experiment Station. This is highly drought-resistant; the present races are found to be much mixed, however, and are now undergoing selection, for the isolation of pure strains. In a similar way, a new variety of sweet corn has been isolated from a mixed lot of ears furnished by the Papago Indians, and is being submitted to careful treatment, which in four years has resulted in doubling the average size of the ear and increasing the yield. This variety promises to be of much value in semi-arid climates.

Eugenics on the Farm

Eugenics is given the first place in the declaration of principles of the Farmers' National Congress, written by Secretary O. D. Hill. It is declared to be the "paramount question of the century." "The American farmer, as a rule, takes great pride in improving his live stock," Mr. Hill says, "but never once seeks to improve the coming generations of his own household." It is urged that this question be kept constantly in the foreground, until it becomes a fixed principle of government.

Tobacco Hybridization

Careful analysis of tobacco hybrids, from a purely genetic point of view, is being made at the University of California; one of the objects is to find just how hybrids can be "fixed" to breed true. The tabulation of more than 10,000 measurements in the study of flower size furnishes as large a mass of data upon the inheritance of a quantitative character in plant hybrids as has been reported in genetics literature up to the present time.



A NEW TYPE OF CATTLE FOR ALASKA

No breeds of dairy or beef cattle have as yet been found hardy enough to stand the winters in the interior of Alaska without excessive expense for food and protection against cold. As a result milk sells for 50 cents a quart and the beef that is consumed in the country consists almost wholly of cold-storage meat brought from the outside, although occasionally a herd of steers is driven in from the coast, the trip to Fairbanks taking a month or six weeks. To remedy this situation as far as possible, the Alaska Experiment Station have undertaken to cross Galloway cattle with the Yak, an Asiatic ox much used by Mongolians, Tibetans, etc., for milk and meat as well as work. It is extremely hardy, pastures through the winter under the open sky in Siberia and obtains feed from last year's dead grass dug from under the snow. Crosses of the Yak and ordinary domestic cattle are common in parts of Asia and have been found of much value. The above photograph from Dr. C. C. Young of Belen, Texas, shows an ox from the Pamirs, the product of a cross between a male Yak and native cow of West Turkestan. It is used for a beast of burden at altitudes of 12,000 feet and more. (Fig. 15.)

Genetics Literature

THE annual reports of the AMERICAN BREEDERS' ASSOCIATION, published in seven volumes, form the most valuable collection of material for students of genetics which has been published in the United States. Most of them are out of print and are becoming very valuable. All of them are nearly indispensable to libraries, institutions and students of plant and animal breeding, heredity, variation, eugenics, or genetics in general.

The Association still has on hand a limited number of copies of three of these reports, which it offers for sale.

Vol. VI, Proceedings A. B. A. (1910), contains 465 pages. Illustrated. It includes 80 papers on general genetic subjects, and among the contributors are practically all the leaders in this study in the United States. **Issued at $2, now offered for $1.**

Vol. VII, Proceedings A. B. A. (1911), and Vol. VIII (1912), bound in one volume of 593 pages, illustrated, and including 73 monographs on the most vital and interesting features of genetics. **Issued at $3, now offered for $1.50.**

The volumes are substantially bound in cloth and will be sent post-paid on receipt of price.

As the Association frequently receives requests for other volumes of the proceedings, which are now out of print, it will be glad to hear from those who have copies for sale or exchange.

In addition to its annual reports, the Association still has on hand a few copies of the following issues of the AMERICAN BREEDERS' MAGAZINE:

Vol. I, Nos. 2 and 4.
Vol. II, Nos. 3 and 4.
Vol. III, No. 2.
Vol. IV, Nos. 1 and 4.

JOURNAL OF HEREDITY:

Vol. V, Nos. 5, 6, 7, 8, 9, 10, 11 and 12.
Vol. VI, Nos. 2, 3, 4, 5, 6, 7, 9, 11 and 12.

Each of these issues contains numerous articles on plant and animal breeding and eugenics, written by specialists and in most cases describing the results of their own researches. In many instances these researches have never been described elsewhere. These numbers will be sold for 25 cents each, post paid.

Address

THE AMERICAN GENETIC ASSOCIATION

511 Eleventh Street Northwest **WASHINGTON, D. C.**

WHAT GENETICS IS

"An exact determination of the laws of heredity," says William Bateson, "will probably work more change in man's outlook on the world, and in his power over nature, than any other advance in natural knowledge that can be clearly foreseen."

To gain this knowledge is the object of the science of genetics, which proceeds, in practice, largely by means of plant breeding and animal breeding, for the reason that heredity is less complicated in these organisms than in Man, and its operation can be more easily made out. The knowledge so gained finds its application in methods for the improvement of cultivated plants and domesticated animals and, most important of all, in the improvement of the human race through the science of eugenics, which was defined by its founder, Francis Galton, as "the study of agencies under social control that may improve or impair the racial qualities of future generations, either physically or mentally."

THE AMERICAN GENETIC ASSOCIATION

is an incorporated organization, co-operative in nature and devoted to promoting knowledge of the laws of heredity in the broadest sense of the word, and their application to the improvement of plants, animals, and human racial stocks. It is the largest organization in the world for the advancement of genetics, and its organ, The Journal of Heredity, is the most important agent for furthering the interchange of ideas between investigators of different phases of these problems, and for the presentation of their results to the public.

Through its committees on research, co-operation with which is not obligatory, but is urged upon every member, the association collects information by means of approved scientific methods applied to the subject of genetics. This information, as well as that derived from other authoritative sources, it endeavors to place before the public by means of its committee on education and extension, and before its membership, in an attractive and understandable way, through this magazine. The association constantly strives to further the cause of conservative, constructive science and to check the progress of fallacious and sensational pseudo-science. While it can not assume responsibility for the accuracy of statements made by contributors to The Journal of Heredity, it endeavors to publish only such as are on a sound scientific basis, and members are urged to contribute such articles, with illustrations. The magazine does not pretend entirely to cover the immense field of genetics, but it is designed to keep members informed of the latest results in research in the most interesting lines, and to present these results in such a way that they will appeal not only to the specialists, but to the general reader who desires to know what the specialists are doing in a science that is of such personal importance to each individual.

REQUIREMENTS FOR MEMBERSHIP

Membership is composed of scientists, teachers, publicists, physicians, clergymen, students, horticulturists, and breeders of live stock, throughout the world. Subject to the approval of the council, any person interested in the improvement of the human race or the creation of better varieties of plants and animals, is eligible for membership. The secretary will be glad to correspond with those interested, and to send a copy of the magazine for examination. Annual dues, giving the right to attend all meetings and to receive the Journal of Heredity, are $2; life membership is $50. Address all communications to

THE AMERICAN GENETIC ASSOCIATION

511 Eleventh Street Northwest **Washington, D. C., U. S. A.**